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REPORT

OF THE

SECRETARY OF AGRICULTURE.

1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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REPORT

OF THE

SECRETARY OF AGRICULTURE.

To the President:

I have the honor to submit herewith my Eighth Annual Report as Secretary of Agriculture.

INTRODUCTORY.

Since my last report progress has been made in securing cooperation with the experiment stations of the several States and Territories; some of the Bureaus of the Department make research in conjunction with all the stations. Preliminary steps have been taken to conduct feeding and breeding experiments in several States looking to the development of breeds of animals suitable to our conditions of climate and soils, and capable of meeting the demands of commerce at home and abroad.

Emergencies arising through the invasion of the cotton-growing States by the boll weevil, a Central American insect that has done much damage in Texas and threatens the entire cotton-growing section of our country, have been met by vigorous work that promises to enable the planters to grow crops in defiance of the pest. The spread over several of the mountain States of a cattle mange required vigorous intervention by the Department. It was necessary to detail a large force of experts to supervise the dipping of the herds in order to eradicate the parasite. Cooperation with most of the States has been arranged, and the rest promise to secure State legislation to compel all flock and herd masters to clean their stock.

The demand in the States for experts to supervise the building of roads suggests the education of engineers in the road laboratory for that work.

The efforts of the Department to create a hardy orange tree that would produce a sweet orange have at last been successful. A hybrid of the Florida orange and Japanese trifoliata has fruited and given us

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the desired result. Another hybrid gives us an orange very similar to the grape fruit, and a third gives us a fruit equal to the lemon for all practical purposes. Other fruits of these hybrids will be valuable for marmalades and cooking.

Valuable research has been made in fruit shipping to foreign countries; the value of promptly placing fruit in low temperatures as soon as it is taken from the tree is demonstrated.

The value of nitrogen-fixing bacteria has been thoroughly proved, greatly increasing yields of leguminous plants and the accompanying production of nitrogen in the soil.

Progress is being made in introducing plants that succeed in light rainfall localities.

Importers of foods and drinks are obeying the law with regard to adulterations and false labeling.

The elements of agricultural science are gradually finding their place in the primary and secondary schools, through the instruction of teachers.

We buy over $200,000,000 worth of products from tropical countries that can not be grown in continental United States. Through scientists sent from the United States to the several island groups the Department is instructing the people of our island possessions to grow these things, such as coffee, rubber, fibers, drug plants, nuts, fruits, spices, and the like.

Our farmers buy $100,000,000 worth of machinery every year. A better knowledge of its use and care is necessary. Several agricultural colleges are taking up this inquiry, and giving instruction in regard to machinery and farm buildings.

AGRICULTURE AS A SOURCE OF NATIONAL WEALTH.

Favored with continued prosperity in 1904, the farming element of the people has laid broader, deeper, and more substantial the foundations of a magnificent agriculture. These happy results have augmented the similar ones of 1903, so that a period of some industrial depression during the last two years has been saved by the farmers from the severer conditions that must otherwise have befallen in consequence of the absorption of a large portion of the readily convertible capital of the nonagricultural classes into great and prevalent speculations. Thus it has happened the farms of the nation have been that sustaining power upon which a basic dependence must be placed in all stresses by a people endeavoring to maintain economic self-sufficiency.

WEALTH PRODUCED BY FARMERS.

As great as the financial successes of agriculture were in 1903, hitherto without equal, those of 1904 advanced somewhat beyond them. While some products have fallen behind in value others have more

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than filled the deficit, and the general result is that the farmers have produced in value much more wealth than they ever did before in one year.

One conspicuous item that has contributed to this is the corn crop. With a quantity closely approaching 2½ billions of bushels, near the record crop of 1902, the high price of this year gives this crop a farm value much greater than it ever had before, far exceeding a billion dollars. With this crop the farmers could pay the National debt and the interest thereon for one year, and still have enough left to pay the expenses of the National Government for a large fraction of a year. The cotton crop, including seed, became the second one in value in 1903, and remains so in 1904. It is now too early to state even with approximate accuracy what the farm value of this crop is, but indications are that the farm value of lint and seed must reach $600,000,000. In this case, as in the case of all other statements herein made concerning crop values for 1904, it must be borne in mind that the amounts have not been finally determined by the Department, that the figures may be considerably changed when the annual estimate is made in the usual way, and that the values are at the farm, and are not commercial values at the exchange or anywhere else.

Hay and wheat are contending for the third place in point of value, although for many years one or the other has held second place or been next to corn. It is expected that these crops, hay and wheat, will together be worth on the farm this year nearly as much as the corn crop, or appreciably more than one billion dollars. Although the wheat crop has a considerably lower production than in any year since 1900, the farm value per bushel is higher than at any time since 1881, so that this is undoubtedly, by a considerable margin, the most valuable crop of wheat ever raised in this country.

It now seems probable that potatoes and barley reached their highest production in 1904; that the oat crop was never so large by 60,000,000 bushels, except in 1902; and that more rice was produced than in any previous year by toward 300,000,000 pounds, so that the present crop of rice has a preliminary estimate of 900,000,000 pounds.

The principal crops that are valued annually by the Department or by commercial houses have an aggregate farm value this year which at the date of this writing apparently amounts to $3,583,339,609. The same crops in 1903, as finally estimated, had a farm value of $3,156,099,392 and had a census value for 1899 of $2,526,345,478. In these principal crops, therefore, the farmers find an increase in value for 1904 of 14 per cent over 1903 and of 42 per cent over the census year five years ago.

On account of the difficulty of estimating the present number and value of farm live stock, it must be sufficient to compare the farm equipment in this respect at the beginning of this calendar year as

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determined by this Department with similar statements made for 1903. Farm horses have increased slightly in number and more in value, and in the aggregate they never were so valuable as in 1904, with a total of $1,136,940,298. The value of farm mules also reached its highest point in 1904, $217,532,832. Cattle have declined a little in number and more in value, and the same is true with regard to sheep and hogs; but the steady advance of poultry in number and in the quantity and value of products leads to some astonishing values for 1904 when the census ratios of increase from 1890 to 1900 are extended to the present year. The farmers' hens are now producing 1⅞ billions of dozens of eggs yearly, and these hens during their busy season lay enough eggs during a period of less than a month, at the high prices of eggs that have prevailed during the year, to pay the year's interest on the National debt.

UNTHINKABLE AGGREGATES.

After a laborious and careful estimate of the value of the products of the farm during 1904, made within the census scope, it is safe to place this amount at $4,900,000,000, after excluding the value of farm crops fed to live stock in order to avoid duplication of values. A similar estimate made for 1903 gives $4,480,000,000, and the census total for 1899 is $3,742,000,000. It is by no means to be admitted that these figures represent fully the value of the wealth produced on farms. Within the limits of ascertainable values, the farms of 1904 produced an aggregate wealth with a farm valuation that was 9.65 per cent above the product of 1903, and 31.28 per cent above the figures for the census year 1899.

An occupation that has produced such an unthinkable value as one aggregating nearly $5,000,000,000 within a year may be better measured by some comparisons. All of the gold mines of the entire world have not produced since Columbus discovered America a greater value of gold than the farmers of this country have produced in wealth in two years; this year's product is over six times the amount of the capital stock of all national banks; it comes within three-fourths of a billion dollars of equaling the value of the manufactures of 1900, less the cost of materials used; it is twice the sum of our exports and imports for a year; it is three times the gross earnings from the operations of the railways; it is three and a half times the value of all minerals produced in this country, including coal, iron ore, gold, silver, and quarried stone.

FOREIGN TRADE.

In the exportation of their surplus during the year ending June 30, 1904, the farmers of the country kept well up to the high level of recent years. The average annual value of the exports of farm products during the five years 1899–1903 was $864,930,137, and the value

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for 1904 was but little below, or $859,170,582. The year 1904 was exceeded by only two years, 1903 and 1901, in the value of exported farm products.

On the other hand, the imports of farm products for the fiscal year 1904 were higher in value than ever before, this value being $462,384,570, leaving an apparent balance of trade in farm products in favor of this country of $396,786,012, or the lowest balance in these products since 1897. The balance declined $25,495,220 in 1904. This is accounted for on the side of imports mostly by increases in the imports of coffee, wool, tea, cocoa, and chocolate; and on the side of exports it is accounted for principally by a decrease of over $72,000,000 in the value of exported grain and grain products which was not balanced by an increase of about $55,000,000 in the value of exported cotton.

During the last fifteen years the apparent balance of trade in favor of this country, all articles considered, was $4,384,574,143. This was owing entirely to the balance of trade in farm products, which during the same time amounted to $5,202,551,016, and was large enough to leave the above-mentioned balance of trade after sustaining adverse balances in products other than those of the farm, amounting to $817,976,963.

INCREASE OF FARM CAPITAL.

The subject of the achievements and financial condition of the farming population may be pursued farther. While the farmers have been increasing their annual product of wealth since 1899 from great proportions to still greater ones, the value of their farm property has gone on increasing. Ratios of increase from the last three censuses indicate that since 1900 the farm land with improvements, including buildings, have increased in value 1⅔ billions of dollars; the implements and machinery, over $100,000,000; the principal classes of live stock (corrected by the Department's information), $240,000,000. Hence the apparent total of the increase in the value of farms and farm property within four years amounts to about $2,000,000,000, a total that seems to be under the fact, since it does not recognize the marked increase in cotton, corn, wheat, and other lands with high crop values during the last two years. The cotton crop brought to planters not merely an increased price per pound, but it at once made cotton lands more valuable to the extent of several dollars per acre, according to numerous reports received by the Department.

EVIDENCE OF THE BANKS.

The improved financial condition of the farmer is indicated expressively by deposits in banks in several States in which there is so little manufacturing and mining that the conditions are chiefly created by

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agriculture. The three agricultural States—Iowa, Kansas, and Mississippi—may be selected for a comparison with the United States as a whole. Individual deposits in the National banks of Iowa increased from June 30, 1896, to October 31, 1904, 137 per cent; Kansas, 212 per cent; Mississippi, 286 per cent; the United States, 92 per cent, or much below the increases of the States named. In the State and private banks deposits during this time increased 128 per cent in Iowa, 227 per cent in Kansas, 306 per cent in Mississippi, and 185 per cent in the United States. In the savings banks of Iowa the increase in deposits was 215 per cent, as compared with 53 per cent for the United States. All kinds of banks being combined, the deposits increased 164 per cent in Iowa, 219 per cent in Kansas, 301 per cent in Mississippi, and 91 per cent in the United States.

A similar comparison favorable to the agricultural States may be made with regard to the number of depositors. In the savings banks of Iowa the number of depositors increased 209 per cent from 1896 to 1904, and in the United States 36 per cent. For National banks, comparison may be made between highly industrial and agricultural States as follows: The number of depositors increased from 1889 to 1903 by 145 per cent in Massachusetts, 117 per cent in New York, 258 per cent in Kansas, and 263 per cent in Mississippi. The increase in Iowa was 184 per cent, the low figure being accounted for by the large development of savings banking.

The Comptroller of the Currency has ascertained the average amount of the daily deposits in National banks, and from his statement it appears that the average daily deposits in October in the National banks of Kansas increased 625 per cent from 1889 to 1903, in Iowa 105 per cent, in Mississippi 89 per cent, in Massachusetts 106 per cent, and in New York 207 per cent.

The farmers' rate of financial progress, as evidenced by the foregoing statements, need fear no comparison with that of any other class of producers. The farmer may not become a millionaire, but he is surer than the millionaire to retain his wealth and to have independence in living.

GENERAL DIFFUSION OF WELL-BEING.

The diffusion of well-being among farmers throughout all parts of the country is one of the most conspicuous features of the recent agricultural development. This attracted attention a year ago and is now even more noticeable; because the great South is more especially enjoying this growth of well-being, owing to the enhanced value of the cotton crop in addition to the general progress in agriculture. The Eastern farmer, who was long on the verge of bankruptcy in competition with the virgin soil and rapid expansion of the northern half of the Mississippi River Valley, has sur-

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vived that competition and now enjoys more normal conditions, owing to the creation and maintenance of many large near-by markets by many varied industries. The Pacific Coast has long been prosperous with its world-famed specialties; the mountain States are glad with the fruits and promises of irrigation; in the older prairie States the farmer has seen his land go from $1.25 an acre, or from a homestead gift, to $100 and $150; and the "Great American Desert," as it was called when it was nothing but a buffalo range, is now peopled by a progressive race of farmers, whose banks are filled to overflowing with the proceeds of their products.

WEATHER BUREAU.

OBSERVATORY BUILDINGS.

Carrying out the policy of the Department, the Weather Bureau has continued to cooperate with the leading universities throughout the country, and at the present time the relations existing are more intimate and the work done more important than at any time in the history of the service. Several universities and colleges have donated ground for the erection of buildings. Appreciation of the value of the work being done by the Weather Bureau has also been demonstrated by several universities in placing at the disposal of the Bureau, without cost, office quarters in their buildings for recently established stations. The erection of buildings by the Weather Bureau saves the amount previously paid for rent of office quarters.

FORECASTS.

Weather forecasts for thirty-six and forty-eight hours in advance have been made daily throughout the year for each State and Territory, and special warnings of gales on the seacoasts, Gulf, and Great Lakes, and of cold waves, frost, heavy snows, floods, etc., have been issued when the advices would benefit commercial, agricultural, and business interests. The North Atlantic and West Indian storm-warning service was continued, and forecasts for the first three days out of steamers bound for European ports were issued daily at 8 a. m. and 8 p. m. In a number of instances European shipping interests were notified of the character and probable course of severe storms that were passing eastward from the American coast. Daily warnings and advices issued in connection with the injurious weather conditions of the year resulted in saving much property.

RIVER AND FLOOD SERVICE.

The floods of the year did not approach in character and importance the overflows of the spring of the year immediately preceding, when over 100 human lives were lost, besides property valued at

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over $40,000,000. There were, nevertheless, severe floods at various times, and in the management of the work occasioned by them the river and flood service continued to demonstrate its usefulness and growing efficiency as a valuable branch of the Weather Bureau. That there has been constant progress in the accuracy of its work is evidenced by the more specific and detailed character of the forecasts and warnings in localities where such exact work had heretofore been considered practically impossible. The service performed during the prevalence of the great winter ice gorges in the Susquehanna, Allegheny, and Ohio rivers, with their attendant floods, was especially noteworthy. These gorges were the greatest in the history of the localities, and that their great dangers were minimized is due in no small degree to the timely advices and warnings of the Weather Bureau.

There were minor floods during nearly every month of the year, but each was amply covered by timely warnings. These floods were not in any sense alarming or dangerous, but they nevertheless attained sufficient importance to endanger a large amount of property.

CLIMATE AND CROP SERVICE.

The National weather and crop monthly and weekly bulletins and the annual summaries and monthly and weekly bulletins issued from the 143 section centers, also snow and ice bulletins, daily bulletins issued in connection with the corn, wheat, cotton, sugar, rice, and fruit services during the growing season, and the special snow bulletins issued during the winter by the sections in the Rocky Mountain and Plateau regions have appeared regularly during the year and have been of great value in affording timely information.

DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

The extensive distribution of daily forecasts by means of forecast cards has continued, and the railway, telegraph, and train services have supplied in the aggregate over 5,000 railroad stations with bulletins generally posted in the waiting rooms for the benefit of employees and the traveling public. The number of addresses on the rural free-delivery list has been greatly decreased as compared with that of the previous year, owing principally to the discontinuance of the afternoon forecast at some of the centers and the transfer of a large portion of this work to the free telephone service. The rural telephone lines are now the best and most economical means of distributing weather information. The forecasts are quickly disseminated, covering a large territory with little or no expense to the Government. By arrangements made with two of the great trunk telephone lines of Ohio the daily morning forecasts are now available for the use of more than 100,000 subscribers in that State, and the records indicate

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that nearly one-half of that number have taken advantage of the opportunity to get the forecasts in their homes within a few minutes after their preparation at the district center.

MOUNT WEATHER METEOROLOGICAL RESEARCH OBSERVATORY.

During the past year the main building of the Mount Weather Observatory has been completed, while the power plant, the building from which balloon ascensions and kite flights are to be made, and the magnetic building are being constructed. The physical laboratory for electrical and radioactive effects is being planned, the erection of which will take place in another year. Finally, a comprehensive physical observatory for photographing the sun directly and through the spectrum, for measuring radiation energy by actinometry and bolometry, with their allied equipment, will be required. This complex institution must grow up slowly as plans can be matured along the best modern lines. When the equipment is ready we shall make and send out apparatus for the exploring of the atmosphere to altitudes of from 3 to 10 miles. It is probable that many balloons will be simultaneously liberated from different stations so as to get records of storms and cold waves from their four quadrants. With observations from the magnetic, the electric, and the solar physics observatories, opportunity for study will be given to those who believe that the cyclonic and anticyclonic whirls that constitute storms and cold waves are mainly the result of changes in the amount or intensity of some form of solar radiation. It is the purpose to make the research at Mount Weather catholic in its broadness.

WIRELESS TELEGRAPHY.

The Department of Agriculture, through the Weather Bureau, was one of the first of the Executive Departments to take up, systematically, experimentation in problems concerned with the development of wireless telegraphy. By this action research into the physical problems concerned in transmitting messages through the medium of ether waves was greatly stimulated in this country. Probably one of the best, if not the best, instruments anywhere made for the receiving of wireless messages had its inception in the experimental work of the Weather Bureau. Recently a board was appointed by you to consider the whole problem of wireless telegraphy and the relation of the Government thereto. Its recommendations, which you approved, will result in the discontinuance of experiments along this line by the Weather Bureau, their transfer to the Navy Department, and the transfer to the Weather Bureau of all the meteorological work now being done by the Navy Department.

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LONG-RANGE FORECASTS.

It is hoped the time will come when it will be possible to forecast the weather for coming seasons, to specify in what respect the coming month or season will conform to or depart from the weather that is common to the month or season; but that time has not yet arrived, and the officials of the Weather Bureau have been informed that they will best serve the public interests when they teach the communities they serve the true limitations of weather forecasting.

EDUCATION IN METEOROLOGY.

The Department is interested in the general introduction of meteorology into the courses of study provided by the universities and higher technical institutions of the country. The mode of teaching and the results obtained were made an important part of the work of the Convention of Weather Bureau Officials which was held at Peoria, Ill., in September, 1904. At an increasing number of educational institutions Weather Bureau officials, in addition to their regular duties and mainly outside of office hours, deliver courses of lectures on meteorology.

TELEGRAPH SERVICE.

To meet as far as possible the pressing demands for a wider distribution of the daily telegraphic reports of observations, arrangements were perfected during the year for a very generous increase in the number of such reports telegraphed over circuits and as special messages, and while for economical reasons it is impossible to satisfy all demands in this respect, it is believed that the present distribution of reports will result in a much more comprehensive display of weather conditions on the maps and bulletins and will give general satisfaction both to the public and to our officials charged with making district and local forecasts. Submarine cables have been laid from Block Island, Rhode Island, to the mainland; from South Manitou to North Manitou Island, Michigan; from Flavel, Oreg., across the mouth of the Columbia River to Fort Canby, Wash.; and preparations are being made for laying one from North Nags Head to Manteo, Roanoke Island, North Carolina.

The reorganization at the beginning of the year of the vessel and wreck reporting service of the Weather Bureau, with additional stations at Sand Key, Florida, and Southeast Farallone, California, has largely added to the effectiveness of this popular feature of the Bureau, and is much appreciated by maritime interests generally. Vessel and wreck reports are now furnished free of charge, except for telegraph tolls over commercial lines, to all corporations and individuals who

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may apply for them. Besides reporting passing vessels, an important service is rendered by these stations in connection with maritime disasters.

INSTRUMENTAL EQUIPMENT.

The Bureau has now 158 stations completely equipped with instruments by means of which an automatic record is made of the direction and velocity of the wind, the duration of sunshine, the amount and time of beginning and ending of rainfall, and the temperature and pressure of the air. With one or two exceptions the stations that are not at present so equipped are of slight importance, or in general have all the instruments necessary for the satisfactory performance of their work. One hundred and fifty-nine steel towers, with the improved auxiliary equipment for the display of storm warnings, are now installed at as many stations distributed over the shores of the Great Lakes and the Atlantic and Pacific seacoasts. At 77 of these stations high-power electric lanterns are used, and at the others improved oil lights.

BUREAU OF ANIMAL INDUSTRY.

Our animal industry is shown only in small part by the figures giving the exports, yet these exports are so large as to be worthy of notice. The animals exported in the fiscal year 1904 were valued at about $48,000,000, which was an increase over the previous year of $13,000,000; the exports of meat and meat products, including oleo oil, oleomargarin, and lard compounds, amounted to more than $174,000,000, a decrease of $4,000,000 from the year before. We also sent abroad nearly $6,000,000 worth of dairy products, and of other animal products, such as hides and skins, glue, grease, and grease scrap, over $5,000,000 worth. The exact total of the above items of export, as given in preliminary returns, was $223,023,060, which was an increase over the previous year of more than $12,000,000. The Department is fostering this foreign trade, as well as safeguarding the live-stock industry within our own country.

INSPECTION OF ANIMALS FOR EXPORT.

The inspections of live stock for export included Canadian animals that pass through territory of the United States; these numbered about 26,000 cattle and 60,000 sheep. The total inspections for export, including these Canadian animals, were 790,496 for cattle, 534,850 for sheep, and 3,293 for horses. As compared with similar figures for the fiscal year 1903, this statement shows an increase of 43.7 per cent in the number of American cattle exported and an increase of 116.5 per cent in the number of American sheep exported. The number of horses exported, however, was reduced by one-third.

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The percentage of loss in transit for the 360,990 head of American cattle landed at the ports of London, Liverpool, and Glasgow was but 0.17; the percentage of loss for the 212,299 American sheep landed at the same ports was 0.94.

The number of clearances of vessels engaged in carrying live stock was 774, and the certificates of inspection issued for American cattle exported to Europe numbered 1,419.

INSPECTION OF IMPORT ANIMALS.

The work of the inspection of import animals calls for the utmost vigilance in order to prevent the introduction of diseases which might prove disastrous to the live stock of this country. Most of the animals that came through the seacoast ports of entry were imported for breeding purposes, but a considerable number of cattle were admitted from Mexico for feeding. The importations of pure-bred animals subject to quarantine were very light during the year, the number at New York, the chief port of entry, having been 266 cattle, 128 sheep, and 123 hogs. The number of farm animals that came through seacoast ports and not subject to quarantine was 2,492; of this total 2,425 were horses. We brought from Great Britain 1,523 horses, from Germany 204, from Belgium 651, and 47 from other countries.

The importations of animals from Mexico were 12,088 cattle, 701 sheep, 314 horses, and various other animals to the number of 203.

An unusually large number of ruminants for menageries, all of which were subject to inspection and quarantine, were imported during the year.

INSPECTION OF MEAT.

The inspection of animals and animal products was maintained at 51 establishments and cities. The total number of ante-mortem inspections was about 65,000,000, whereas in 1903 the number was about 59,000,000; this shows an increase of 6,000,000 animals. The post-mortem inspections amounted to nearly 40,000,000, which was an increase, except as to sheep, over the year 1903. The increase in 1904 in the number of hogs inspected post-mortem was over 2,000,000.

The meat-inspection tag or label was affixed to 22,943,067 quarters and 120,404 pieces of beef, 8,230,528 carcasses of sheep, 765,301 carcasses of calves, 1,122,193 carcasses of hogs, and 726,779 sacks of pork. Besides, the meat-inspection stamp was affixed to 23,000,000 packages of meat and meat products that had received the regular post-mortem inspection.

Compared with the figures of 1903, the statement for 1904 shows an increase in beef exports of 47,138,044 pounds, a decrease in mutton exports of 2,016,924 pounds, and an increase of pork exports of 21,319,830 pounds—a net increase of 66,440,950 pounds for all.

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In the matter of the microscopic inspection of pork there was a great decrease, from 19,000,000 pounds in 1893 to 9,000,000 in 1904. This inspection is restricted to the pork that is destined for those countries which require such safeguard. The number of carcasses thus inspected in 1904 was 315,045. The number of carcasses found to be trichinous was 2,643.

The cost of the ordinary inspection was $781,590.95, and the microscopic inspection cost $53,934.01. Each hog carcass cost 17.1 cents for its inspection and each pound of pork exported 0.6 cent.

CATTLE SCAB, OR MANGE.

The existence of scab, or mange, in cattle has for several years past often been brought to the attention of the Department. As early as the spring of 1901 inspectors in the field recognized that scab of cattle was a contagious disease, and asked for instructions regarding it. The disease continued to spread, and during that year numerous inquiries were received as to how the disease could be cured and controlled. It became generally known that the dipping of cattle was the best method of treatment, and the Department received many calls for information as to the construction of vats and the best dips to use. In January, 1902, a bulletin describing scab of cattle and its treatment was issued. There was a large individual demand for this publication and it was supplied to many State authorities for general distribution.

In spite of efforts to disseminate all the information possible on the subject, the disease spread to an alarming extent, especially on the Western ranges, where the cattle roamed over large areas, and where a few infected animals introduced would communicate the disease to others until the whole band was affected. So extensive was the distribution of the scab that in June, 1903, the Department issued regulations for controlling it, stating that the disease existed among cattle in that part of the United States lying west of the Mississippi River, including the State of Minnesota. These regulations did not apply to the Eastern part of the United States. At that time all of the available funds were used for the employment of inspectors in the Western country in the eradication of scabies among sheep, and there were but a few men who could be used for enforcing the regulations for preventing the spread of scabies among cattle. Many of the Western States, notably Colorado, began during this year to take measures for suppressing the malady within their limits. These States, however, were unable to prevent the disease from being introduced from other States, consequently very urgent appeals were made from State authorities asking that supervision by this Department be extended to cattle scab.

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It was apparent that, unless the Federal authorities undertook measures for its control, the States would suffer disaster, not only from the loss of stock affected, but from the embargo which would be placed upon cattle passing from an infected State to one where the disease did not exist. The disease became so prevalent that it was carried from the ranges to the feed lots in States of the Middle West, and there was danger of injury to the trade in live cattle for export to Great Britain. When the scab became so common on the ranges, it was found that unless the cattle were dipped before shipment the cars in which they were loaded became infected; also the stock pens, where the cattle were unloaded for food and rest en route, as well as the stock yards at the leading markets. It became imperative, therefore, that a campaign should be entered upon, and accordingly in March, 1904, regulations were issued applying to all of the United States and prohibiting shipment of cattle affected with this disease from one State to another.

Provision was made in these regulations for allowing shipment after cattle were dipped, and, though affected with the disease, they could be shipped for immediate slaughter after one dipping; but if cattle were intended for feeding or stocking purposes, they must be held for the second dipping, ten or twelve days after the first one. To secure the enforcement of these regulations, it was necessary to station a large number of inspectors in the Western States, particularly the range States where shipments of cattle originated and where the disease was most prevalent. So far as possible the force of inspectors already in this region was used; but this was entirely inadequate to the demands and required an extensive increase, so that at the present time more than two hundred men are in the field engaged in the inspection of sheep and cattle for scabies.

There was an urgent call for inspectors, mostly from persons who had cattle to ship and those who owned affected cattle which required dipping. This dipping in several States was done in cooperation with the State authorities and under the supervision of Federal employees. Shipments of cattle from ranges known to be infected could not be made to market centers without a certificate showing freedom from scabies, or to the effect that the cattle had been dipped and could be transported without spreading the contagion.

During the first nine months of this year, in the 34 States and Territories where this inspection was maintained, 3,843,075 cattle were inspected for scab; 168,203 were found affected with the disease, and 300,275 were found to have been exposed to it. The total number of cattle dipped during this period, under official supervision, was 420,762; 116,362 affected cattle were given one dipping, and 76,974 affected cattle were dipped a second time, after an interval of ten or twelve days. This work necessarily increases the expenses of the

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Bureau, which, for the month of January, 1904, amounted to $404.65 for this inspection exclusively, and in September, 1904, to $11,770.70.

FOOT ROT AND GID OF SHEEP, AND RABIES.

Besides the several lines of work which have been carried on through a series of years and which have been reported upon from time to time, special work has been done with reference to foot rot of sheep and the disease of sheep commonly known as "gid." In a recent shipment of sheep which arrived at the Buffalo stock yards 75 per cent were found to be affected with foot rot. This disease is not at all uncommon in the sheep-raising parts of the country, and its eradication is not a very difficult undertaking. A bulletin is now in press which deals with all of the phases of foot rot, and should enable the sheep raiser to clean up his flock without much difficulty or great expense.

Although the conditions prevailing in this country are considered unfavorable to the parasite causing gid, the disease, nevertheless, has gained a foothold in the Rocky Mountain States, and it is therefore well to understand the life history of the parasite causing the disease and the methods of dealing with it. It is reported that a few years ago the loss of sheep from gid in France was as great as 1,000,000 annually. This subject has received a thorough investigation, the results of which will soon be published.

Investigations regarding the presence of rabies, or hydrophobia, in the vicinity of Washington, D. C., were continued during the year. Of the 38 suspected cases examined positive results were obtained from 22, of which number 13 were from the District of Columbia.

TUBERCULOSIS.

The work on the subject of tuberculosis has been conducted throughout the year along lines which have been planned for several years. Some experiments which have been recently reported upon by this Bureau go to show conclusively, it is believed, that it is an error to conclude that cattle can not be infected with human tuberculosis. These experiments not only justify but show the desirability of a rigid enforcement of public regulations looking to the control and the eradication of tuberculosis in cattle.

The demand for tuberculin greatly increased during the year. The amount distributed in 1904 was 74,000 doses, while in 1903 the number of doses was 47,000.

DISTRIBUTION OF BLACKLEG VACCINE AND MALLEIN.

The blackleg vaccine for cattle which is manufactured and distributed by the Bureau of Animal Industry continues to give satisfactory results. During the year the number of doses that were sent out fell off somewhat from the report of the previous year; but the number of

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persons supplied was slightly increased. It is interesting to note that, in 1904, 1,000,000 doses of the vaccine were used and reported upon by over 10,000 persons with highly satisfactory results. After a careful analysis of the figures which were compiled from the reports from the users of blackleg vaccine, and eliminating the deaths which could in no manner be properly charged against the action of the vaccine, the number of cases that died after vaccination is reduced to the very low figure of 0.44 per cent.

The manufacture and distribution of mallein in 1904 for glanders in horses was about the same as in the previous year, and the number of doses sent out was 7,000.

INSPECTION OF DAIRY PRODUCTS.

Under the act of Congress approved May 9, 1902, the Bureau of Animal Industry is charged with the inspection of certain dairy products which are designed for interstate commerce, especially the article of renovated butter. This work is now fully organized and is governed by joint agreement of the Treasury Department and the Department of Agriculture. The reports for 1904 show that there were 73 factories licensed and bonded, which was a reduction of 9 from the previous year. These factories were located in 14 States and the District of Columbia. The quantity of renovated butter made at bonded factories during the fiscal year of 1904 was about 54,000,000 pounds. The average quality of renovated butter is improving. The difference in general character, since the inspection was inaugurated, is very marked. This is due, in part, to improved machinery and processes, and largely to the better average quality and condition of the "packing stock" or raw material used.

Such stock is now closely collected in the producing districts, so that accumulations of country butter at remote points and involving deterioration are not frequent. More care is taken in sorting, packing, and storing the stock. Occasionally a lot of packing stock is found in such a condition of filth or putrefaction as to necessitate condemnation. In still rarer cases the manufactured product is found to be so bad, because of bad materials, ignorance, or negligence in renovating, or as the effect of age, as to make it unfit for food. In a few such instances the sanitary inspection required by law and made by this Department has caused the objectionable materials and products to be removed from the food market and sold as grease. But, as stated, such instances are not frequent. Although there is still opportunity for great improvement in materials, in the manner of handling and transporting the same, in factory management, and in the finished product, it is true that the manufacturers are endeavoring, as a rule, to improve conditions at all points and are ambitious to win a reputation for producing an article of high quality.

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BUREAU OF PLANT INDUSTRY.

In no field of industrial work have there been greater advances during the past decade than in the improvement of plants and the methods of growing them. The Bureau of Plant Industry has done much to bring about these advances. Diseases have been studied and remedies found, new varieties of plants have been created and new industries established, and the world has been searched for better things, all for the purpose of helping the farmer and making his work less burdensome and more profitable.

GROWTH OF THE WORK.

Since the Bureau of Plant Industry was organized, three years ago, the demand for more work has been so great as to require an increase of nearly 50 per cent in men and funds to conduct it. There are now in the Bureau about 500 workers, 60 per cent of whom are engaged in scientific investigation and its application to the farm, the orchard, and the garden. The Bureau is endeavoring to train young men as rapidly as possible for this work. The agricultural colleges furnish a part of these men, but the demand for those with proper qualifications is still greater than the supply.

ENCOURAGING INTEREST IN FARM LIFE.

The Department is not an educational institution in the strict sense of the word, but it can do and is doing much to bring home to the people in all walks of life the importance and value of the farm and its productions. The Bureau of Plant Industry is making a special effort to encourage the study of plants in the public schools. The future welfare of this country depends upon its agricultural development, and it is important and vital that a knowledge of the opportunities in this field should early be brought to the attention of the child. Unfortunately, our system of elementary education is such as to leave no impression on the child's mind of the importance, value, and usefulness of farm life. The child is, in many ways, brought early into contact with facts which point to him the value of commercial life. He is, therefore, early inoculated with the belief that to reach the highest possibilities he must, if he is on the farm, migrate to the city. It is to be regretted that farm life in the past has not always been conducive to the encouragement of young men to remain on the farm.

Very little effort has been made to overcome the general belief that there is always a great amount of drudgery connected with the farm, and that the opportunities in this sort of occupation are narrow and limited. When we see the rapid advances that are being made in agriculture along all lines and note the need for bright young men in this

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field, the opportunities offered by the cultivation of the soil seem as great as in any other field. In order to bring these matters clearly home to the children, efforts are being made by the Department to encourage the growing of plants in connection with the public school work. The general distribution of seed is being handled in such a way that the encouragement of plant growing will be a feature of it. Wherever it has been practicable to influence school authorities, this has been done. Various members of the staff of the Bureau are constantly endeavoring by publication of papers, lecturing, etc., to point out the advantages of rural life.

DEVELOPING NEW INDUSTRIES.

RICE PRODUCTION.

The Bureau of Plant Industry has continued its efforts to encourage rice production in the Southern States, especially in Louisiana and Texas. A special farm for the growing of rice has been placed at the disposal of the Department, and upon this farm various questions relating to the industry are being worked out. New varieties of rice are being tested, questions pertaining to the best methods of improving the seed are being settled, and other important problems are under investigation. There has been an enormous increase in the production of rice in the States of Louisiana and Texas during the past three years. As the industry has developed, the necessity has become more and more evident for paying special attention to the improvement of cultural methods.

In the early days of the industry the crop was so profitable that little attempt was made to obtain information on important matters, such as the necessity for rotation, the best methods of handling the water, means of controlling diseases and weed pests, and other important subjects. As competition has become greater and the production larger, farmers are realizing the necessity for paying strict attention to all details connected with the work. Preliminary estimates show that during the year 1904 the area devoted to rice in Louisiana and Texas was 600,000 acres, and the crop will approximate 650,000,000 pounds of rough rice.

DURUM WHEATS.

The success attending the introduction and growing of the durum or macaroni wheats continues unabated. The past season has been a particularly trying one for all wheats in the Northwest. Rust has caused great damage in many localities, but the durum wheats have been in most cases resistant. Probably no less than 14 million bushels of these wheats will be grown the present season, and the evidence at hand indicates that great quantities of the wheats are being saved for

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seed for next year's planting. Owing to the almost total loss of other wheats east of the area where the durum wheats succeed best, efforts will probably be made next year to plant the durum wheats farther east than they should be planted. It must be remembered that these wheats are specially adapted to semiarid regions, and moving them into humid regions may result in disappointment.

It is gratifying to announce that the durum wheats are now being handled without difficulty by many of the millers, and regular grades corresponding with the grades of other wheats have been established in the markets. From the outlook at present there will be not less than 40 or 50 million bushels of these wheats produced next year. The fact that these wheats are valuable for bread and that they can be grown successfully where most other crops fail is an exceedingly important thing for the agricultural development of the great semiarid West.

THE MATTING INDUSTRY.

The United States imports large quantities of mattings from the Orient. These mattings, for the most part, are made of a species of rush which might easily be grown in this country; in fact, there are already here several native forms which undoubtedly would prove valuable for the manufacture of fine mattings. Special American machinery has been devised and is now in use in the manufacture of a very high grade of mattings. So far, the raw material used by these machines has been imported. During the year the Bureau of Plant Industry has introduced and disseminated considerable quantities of the rush, with the object of securing a sufficient amount to supply American manufacturers with the product. The results accomplished have already proved encouraging, and the work will be continued.

SUGAR-BEET GROWING.

The development of the sugar-beet industry continues satisfactory. The Bureau of Plant Industry is making an effort to improve the conditions affecting this crop in the matter of providing better seed, encouraging the use of fertilizers where fertilizers are likely to do good, studying the diseases with a view to discovering remedies for them, securing improvement in the matter of seed by the production of beets which will give seed of a single ball or germ, etc. A little more than two years ago the Department again took up the work of establishing sugar-beet seed culture in the United States, and since that time work has been going on in four representative sections of this country. Strains of pedigreed seed are being established in New York, Michigan, Utah, and Washington State, while in Utah and Washington the industry is already assuming commercial importance.

In California also seed is being produced for local use. In Wash-

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ington State 80,000 pounds of seed were produced in 1904, in Utah about 32,000 pounds, and in California about 50,000 pounds—a total of 162,000 pounds. As rapidly as the Department can bring home to all the sugar-beet factories the conviction that American-grown seed is as good and often better than the imported, these quantities will be increased, and it is a question of but a few years when the entire 5,000,000 pounds used in the United States will be produced at home.

As to the quality, American-grown seed has produced beets testing as high as 24 per cent of sugar, while the average percentage in all beets tested from American-grown seed during 1903 was 15.8 per cent. The average percentage of sugar in all beets grown in the United States, as shown by the factory returns of their total extractions, is a little over 11 per cent. It will be remembered, too, that the American seed has the benefit of only two years of careful selection. The work of establishing a pedigreed strain is slow, and years are required for the completion of such an undertaking; but the work is so far along that its success may be considered assured.

Two years ago the Department imported all the sugar-beet seed that was distributed for experimental purposes, while during the 1904 season 14,000 pounds of American-grown seed were distributed by the Department to selected farmers for testing in comparison with imported seed furnished to them by the factories. The reports on the stand secured, which is generally indicative of the yield, show that the American seed gave almost without exception a greater and a stronger growth than the imported seed. In a number of instances those portions of fields which were sown with factory seed gave such a poor stand that they had either to be resown or abandoned, while the portions sown with American-grown seed gave good stands and in no case required replanting. The factories during 1904 bought 34,500 pounds of American-grown seed, and a number of these factories are now negotiating with the American growers for contracts to supply the seed they need.

In the fertilizer work efforts have been made to determine the effect of different fertilizers on tonnage and sugar content, and also their influence on various diseases.

Investigations along this line were undertaken in six sugar-beet States, seven brands of complete fertilizers being used, and in addition some separate experiments with the various ingredients used by themselves were made. The preliminary reports which have been received indicate that in many cases the effect of the fertilizers could be seen from the time of the germination of the beets. In a few cases the lines separating the fertilized from the unfertilized plots could be seen even at the beginning of the harvest. A recent report from one of the experimenters states that in his work with nitrate of soda the beets from the untreated plots were worth $5.20 per ton and yielded

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$54.35 worth of beets per acre. On the adjacent plot, where 300 pounds of nitrate of soda were applied at the time of planting, the beets were worth $5.30 per ton and yielded $74.57, a difference of $20.23 per acre in favor of the fertilization. The untreated beets tested 14.1 per cent sugar, while those fertilized tested 14.4 per cent.

The serious epidemics which have affected the sugar beet, like the leaf-spot disease of the East and the curly top of the West, have been investigated. Experiments on a large scale in different sections of the Eastern beet area have shown that the leaf-spot may be readily controlled by the application of Bordeaux mixture. This remedy has now come into general use.

In my last report attention was called to the efforts being made in the matter of developing sugar-beet seeds with single germs. The single-germ seed would do much to diminish the labor of thinning. The Bureau work in this field has been very satisfactory. Although the work has been running for only two seasons, decided progress has been made, and the single-germ seeds that have been selected have been found much more vigorous than the multiple-germ balls. The selected strains grown this year show a decided tendency to the production of a larger number of single-germ balls than the parent beet from which the selection was started, the average gain being about 20 per cent. In one case, over 3,000 single-seed balls were found on one beet. The work this year has been conducted in Utah and other sections where the sugar beet is at its best, and indicates that ultimately we shall in all probability be successful in the production of a beet having the desirable quality of producing only balls with single germs, that will substantially save hand thinning and avoid much expense in growing.

NEW CITROUS FRUITS.

The efforts that have been made by the Bureau of Plant Industry for a number of years in the matter of producing, by breeding, new citrous fruits, so as to build up varied industries in the South, have met with very gratifying results. The hardy sour oranges which have been secured as a result of crossing the sweet orange with the hardy Japanese orange are now ready to distribute, and the work of distribution will be inaugurated in the coming winter. These new hardy oranges will unquestionably make possible the development of several important industries in the South. The oranges are valuable for marmalades, and from the fact that they may be grown in nearly all the Southern States, great possibilities for their usefulness are opened up. Even if they should not come into general use for manufacturing purposes or for general orchard planting, they will undoubtedly eventually become a feature in every dooryard throughout the South. Aside from their value for the manufacture of marmalades and preserves, they will be exceedingly useful for pies and other purposes.

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There has been fruited this year for the first time a sweet orange of the hardy type. This is an accomplishment which the Department hoped for when it first inaugurated the work. The other new citrous fruits developed from the Bureau's investigations, such as the new tangelo, which is a cross between the tangerine and the pomelo, a new velvet-skin orange, and several other creations, will all prove exceedingly valuable in sections where the climatic conditions will permit the growing of these more tender sorts.

AMERICAN TEA.

The Department has continued its work in the production of American tea. The more advanced investigations have been conducted, as heretofore, at Summerville, S. C., in cooperation with Dr. Charles U. Shepard. Doctor Shepard's tea gardens are now yielding from 8,000 to 10,000 pounds of tea annually. Owing to climatic conditions the crop this year will be light. Doctor Shepard has been devoting special attention to the improvement of factory processes. Several new inventions have been made by him in the matter of tea rollers, apparatus for the manufacture of green tea, and apparatus for a process of attrition, giving to the tea the beautiful bluish cast, or finish, which heretofore has been secured in foreign countries by the application of various chemicals.

Doctor Shepard's process puts this finish on the teas by simple attrition or friction, and is a marked advance over the old processes. The work of establishing a plantation in Texas has been continued. Tea beds were started on two types of soil—a rich sandy loam and a black, waxy soil. The plants on the black, waxy land have failed utterly. Fortunately this discovery was made before any extensive plantings had been undertaken, and it will lead to the extension of the plantings on the sandy loam soil. There are now on hand at our Texas station, which is located at Pierce, about 100,000 plants, which will be put into the field this winter, planting about 40 acres. Sufficient additional seed will be put out to give another 50 acres next year.

AMERICAN DATES.

Encouraging results have been secured in the establishment of this industry in the southwestern portion of the United States. The date orchard at Tempe, Ariz., is progressing in a highly satisfactory way. The work here has been carried on in cooperation with the Arizona experiment station and has been under the direct supervision of Prof. R. H. Forbes. In cooperation with the California experiment station, work on the establishment of date culture in southern California is also being conducted. Ten acres of land have been secured for an experimental orchard and dates have been and are being planted there.

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The industry has been further encouraged by the publication of important reports on the subject, pointing out available localities where the crop is likely to succeed. There is a considerable extent of territory in southern California where practically all of the dates of a certain class which are now imported could in all probability be grown. These regions have been mapped and a special effort has been made to encourage the production of the crop therein. Various importations of the date have been made during the year and others will follow from time to time as the industry advances.

BULB GROWING.

The very specialized conditions of soil and climate necessary for the proper production of bulbs and the peculiar nature of the skilled labor required have made the establishment of the bulb industry difficult. However, investigations have shown that nearly all of the so-called Dutch bulbs may be grown in the United States, and that one by one the difficulties due to competition of cheap skilled labor, excessive cost of transportation, and the natural hesitancy on the part of purchasers to use an untried article will be overcome. A method has also been discovered by the Department experts to produce the Bermuda lily bulb free from disease. Of the millions of lily bulbs annually imported, it is safe to say that 40 per cent are more or less affected by disease. The eventual elimination of this trouble will be due to the work of the Department.

AMERICAN-GROWN DRUG PLANTS.

In Vermont, the previous success in growing opium poppies has been repeated with even more satisfactory results, both the white-seeded and blue-seeded sorts giving good crops. The attempt to cultivate this plant has been made with the object in view of testing the possibility of developing in this country a means of supplying our demand for poppy alkaloids for medicinal uses. The present source of these—morphine, codeine, etc.—is to be found in crude opium, of which approximately a million dollars' worth is imported annually. The cost of these products is in large part due to the labor involved, and the efforts of the Bureau have been directed toward devising some process whereby the alkaloidal principles can be isolated directly from the extracted juices of the plant. Up to the present time no one has succeeded in obtaining morphine from these extracts.

During the year an expert of the Bureau has, however, met with success, and we are now able to obtain morphine directly from the expressed juices of the plant. This method does away with much of the expense. Experiments are now being undertaken to ascertain the practicability of obtaining morphine directly from the plants as a

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commercial source. If the experiment indicates a favorable outcome the plants produced in American fields will replace oriental opium as a crude source for morphine.

SWEDISH SELECT OAT.

The experiments of the Department with this hardy Swedish oat ceased some time ago, but highly interesting reports in regard to its usefulness are still coming in. It was introduced about five years ago by the Bureau of Plant Industry and distributed in a number of the Northwestern States. It has high qualities as a yielder and is especially valuable for resisting drought.

It has now become the most popular variety in the States of Wisconsin, North Dakota, Montana, portions of Idaho, South Dakota, and Minnesota. In one instance in Wisconsin, from the planting of 33 grains in the spring of 1899, there resulted a production of about 20,000 bushels in the year 1903, and a half million bushels in the present year, 1904. It is expected that the present year's crop will show that about 4 million bushels of this oat are being produced in Wisconsin. Although the highest legal weight of oats is 36 pounds to the bushel, this variety commonly weighs from 40 to 44 pounds in the Northern States, and occasionally reaches from 48 to 50 pounds to the bushel.

SPECIAL WORK ON COTTON.

The Bureau of Plant Industry has made a special effort to aid the farmers of Texas, Louisiana, and other Southern States where the Mexican cotton boll weevil has already appeared or is likely to appear. In all sections the energies of the Bureau have been put forth to encourage better methods of farming, with highly gratifying results.

COOPERATION WITH FARMERS.

With a view to bringing directly home to the farmers of Texas and Louisiana, especially those in the boll-weevil districts, the advantages of better methods of cultivation, the value of early maturing seed, etc., the Bureau organized an extensive line of propaganda work. The farmers in the various counties were organized and were brought into cooperation in such a way that large plantings were made under the direct supervision of the Department. Tracts of 5, 10, 15, and 20 acres were handled by individual farmers, under working plans furnished by the Bureau, the object being in all cases to demonstrate the practicability of growing cotton despite the presence of the weevil.

More than 5,000 farmers were engaged in this work, and the results have been highly satisfactory. At a recent meeting held in Houston, where more than 200 representative farmers from all parts of the State were present, records were presented showing the yields of cotton

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under the plans of the Department compared with old methods. The increased yields, ranging all the way from 25 per cent to 100 per cent in districts badly infested by the weevil, show that by proper methods of culture, the use of early maturing varieties of seed, and the application of proper fertilizers excellent results may be obtained. A complete record of the yields from the various farms conducted under the direction of the Bureau has been kept, and a report embodying these data will soon be published.

COOPERATION WITH THE TEXAS AGRICULTURAL COLLEGE.

In the special work on cotton the Bureau of Plant Industry has been in the closest cooperation with the Texas Agricultural College. The president of the college has taken charge of the farmers' institute work, and with the aid of several men selected by him and men furnished by the Department all parts of the State were visited early in the spring, and the necessity for giving strict attention to better methods of cultivation was set forth. This institute work will be continued during the present autumn and winter. In addition to the institute work, the Bureau has been cooperating with the college in the matter of the breeding of cotton, the testing of fertilizers, and other important lines of investigation. Thorough harmony prevails, and every effort is being made by both the Department and college officials to make the work effective.

COOPERATION WITH LOUISIANA AUTHORITIES.

Cooperation has also been secured with the Louisiana authorities, and a number of important lines of work have been carried on in the State. The propaganda work, as described for Texas, has also been conducted in portions of Louisiana. Demonstration work with fertilizers has been carried on; also other investigations having for their object the encouragement in every way of better methods of farming in advance of the approach of the weevil.

DIVERSIFICATION FARMS.

As another feature of the work in the South, plans were made and put into operation establishing diversification farms at various places. The object of these farms was to show the value and importance of diversified agriculture. It was found unnecessary for the Bureau to expend any funds in the development of these farms, except in minor ways for the purchase of certain special seeds, and sometimes for special fertilizers where such were to be used. In all cases the business interests of the respective communities gladly cooperated with the Bureau to the end not only of securing a desirable farm for the purpose, but assuming all responsibility for its support. In every

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instance efforts have been made in organizing these farms to make them not only self-supporting but profitable. The main object of the work is to show that by diversified agriculture the lands may not only be improved, but more money can be made than in farming with a single crop.

Thirty-two of these farms have been or are about to be established, of which 16 are in Texas, 5 in Louisiana, 3 in Georgia, 2 in Alabama, 3 in Mississippi, 2 in South Carolina, and 1 in Florida. The general method employed in locating, organizing, and conducting these farms is to first determine in what section of the State the various farms are to be located. An effort is then made to find a progressive farmer who is desirous of encouraging diversified farming in his section, and who is willing to permit the Department to aid him in doing it. When a suitable arrangement has been made, a representative of the Department and the State experiment station make a thorough study of local conditions with reference to cropping possibilities, markets, advantages, etc. A system of records is instituted, which enables the Department to secure detailed information regarding every phase of the management of the farm and the results secured. After the farms are established, other farmers are encouraged to visit them, this being done largely through the cooperation of the State experiment stations.

BREEDING NEW TYPES OF COTTON.

Extensive work has been inaugurated in Texas having for its object the breeding of new types of cotton better adapted to meeting the conditions brought about by the invasion of the weevil. More than 100 varieties of cotton have been grown and many selections have been made. This is necessarily slow work, but already very encouraging results have been secured in the matter of obtaining earlier and better yielding types—types that are better able to resist storms and types for special purposes in several regions.

DISCOVERY OF THE GUATEMALAN ANT.

During the year an important discovery was made by an officer of this Bureau, viz, the discovery in Guatemala of an ant that destroys the weevil. Eighty-nine colonies of these ants were brought into Texas and are now being thoroughly studied with a view to determining their value as a means of checking the serious inroads of the cotton insect. After the introduction of the ant by this Bureau further work on its distribution, habits, etc., was placed under the Bureau of Entomology.

WEEVIL-RESISTANT COTTON.

Another and perhaps more efficient method of combating the boll weevil than by means of the ant has been discovered very recently.

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The hope of finding a variety of cotton not subject to injury by this pest has been cherished for several years, but hitherto no method has been ascertained by which the plant could offer effective resistance to the insect. It has been found, however, that in some varieties of cotton the presence of the larva, instead of blasting the buds and bolls, often stimulates a special growth of internal tissue which kills the young weevil. This is not merely accidental or abnormal, but is in the nature of a protective adaptation developed as a final result of a long struggle for existence between the cotton and the weevil in tropical America. The insect could not breed or perpetuate itself in the presence of a variety of cotton in which the formation of the new protective tissue occurred regularly. It is accordingly within the range of scientific possibilities that resistant varieties of cotton can be found in tropical America or developed by selection, and work on this line has been begun.

DISTRIBUTION OF EARLY-MATURING VARIETIES OF COTTON SEED.

With a view to encouraging the planting of early-maturing varieties of cotton, such as King and Parker, a large distribution of these varieties was made in the State of Texas and a portion of Louisiana during the year. Small quantities were sent to farmers, the cooperation of Senators and Members of Congress being secured for the purpose of distribution. Records have been kept of all the farmers who received this seed, and reports are now being returned to the Department as to its value as compared with ordinary sorts. In most cases very encouraging reports have been received as to the use of the early-maturing seeds, and the chief value of the work will be in the fact that from this distribution the farmers themselves may start the selection of stock seed for future planting.

INVESTIGATION OF THE COTTON ROOT-ROT.

As a feature of the work in Texas a special effort has been made to obtain information as to the best methods of combating the cotton root-rot. This disease has been very serious the past season, destroying large areas of cotton in many portions of the State. Efforts have been made to secure resistant types, but so far the results obtained have not been very encouraging, although some progress has been made. Experiments have been made for the purpose of determining the value of soil treatments, seed treatments, and other methods of combating this disease, including crop rotation. This work has just been started, and it is too early yet to determine its value.

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PROGRESS IN COMBATING PLANT DISEASES.

CRANBERRY DISEASES.

Important advances were made during the year in the matter of treating cranberry diseases. The cranberry crop is an important one in this country, aggregating in value a million dollars or more annually. In recent years several destructive diseases have caused a great deal of damage, and until the Department began its investigations little progress had been made in the matter of treatment. Experiments the past year in the treatment of one of the most serious diseases, commonly known as "scald," have been quite successful. It has been demonstrated that this particular disease may be prevented by the application of fungicides at very small expense.

ERADICATION OF LITTLE-PEACH DISEASE.

The efforts made by the Department in the matter of demonstrating the feasibility of eradicating the little-peach disease from the orchards of Michigan and other States have been continued on a large scale. A section 3 miles square in Michigan was selected for this work and the orchards were thoroughly gone over three times during the months of July, August, and September and all of the affected trees were destroyed. The object of this experiment is to demonstrate what is believed to be a fact, viz, that the disease can be entirely eradicated by the extirpation process.

WINTERKILLING OF FRUIT TREES.

The extreme cold of the past winter caused the extensive killing of fruit trees in many portions of the Northern States. At the approach of spring the trees had the appearance of being seriously injured, and undoubtedly a great many would have been destroyed but for the timely aid rendered by the Department in the matter of suggesting proper means of handling such injuries. A brief report was issued as a guide to the owners of the frozen trees, and this undoubtedly saved many orchards from needless destruction.

DISEASES OF TOBACCO.

The most serious disease of tobacco in the United States during the past season has been the new malady called "wilt." This has been very destructive in certain portions of the South, and so rapid has been the spread of the trouble that it threatens the complete destruction of the large tobacco industry in North Carolina. Evidence is at hand that this disease is very similar to other wilt troubles, and that it may eventually succumb to treatment through the selection and development of resistant types. Work with a view to securing these types is now being conducted.

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WILT DISEASE OF COTTON.

The success of this Bureau's wilt-resistant varieties of cotton was more marked last season than ever before. An improved selection from the Rivers cotton remained entirely free from the wilt on the worst infected land on James Island, South Carolina, where the finer types of Sea Island cotton are grown. These cottons, originating through the efforts of the Department, are not only wilt resistant but have a finer and better staple than the original nonresistant strains, thus disproving the assertion that resistance to wilt had been obtained at the sacrifice of quality. Considerable quantities of the seed of resistant and desirable strains of cotton have been obtained and distributed. In connection with this work the wilt of the cowpea has also been studied and resistant types secured and distributed. About 200 bushels of the resistant cowpea seed were sent out last spring. This work is being developed as an auxiliary to the cotton investigations, as it has been found that many thousands of acres of sandy soil in the Gulf States are infected by both the wilt and root-knot, and the cultivation of the ordinary cowpea results in great injury to the cotton.

ADVANCES MADE IN FORAGE-CROP WORK.

ALFALFAS AND CLOVERS.

Alfalfa has attracted more attention on the part of farmers in the eastern half of the United States during the past two years than any other crop. The Department has demonstrated that it can be grown in almost every State in the Union. Varieties have been found which withstand the rigorous winters of the northwestern prairie States. Other varieties have been found which are immune to the alfalfa leaf rust. There is still much to be learned concerning the adaptability of alfalfa to various types of soil in the Eastern States, and much time is being devoted to the solution of this problem. The cultural methods required for establishing and maintaining alfalfa meadows are also receiving due attention. The subject of clover sickness, a matter of very great importance to farmers throughout the clover region, is being investigated. New varieties of clover which appear to possess some advantages over the standard varieties grown in this country have been secured and are being propagated with a view to introducing them generally in the clover region as soon as sufficient seed is available. Some of our native clovers are being grown under farm conditions in order to determine whether or not they are worthy of domestication. One or two of them are promising, particularly for sections of the country where red clover does not thrive.

SOIL AND SAND BINDERS.

Methods of holding drifting sand in place have been thoroughly worked out. An agent of the Department has made a careful study during

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the past two years of the methods which have been developed in Europe in work of this character, and demonstrations of these methods are now being made in portions of the country where drifting sand is most troublesome. Attention is also being given to plants adapted to hold banks and the sides of cuttings in place, and several plants which possess high value for this purpose have been found. This work is of particular interest to civil engineers, and in prosecuting it the most hearty cooperation from them has been received.

RANGE INVESTIGATIONS.

During the past year a large amount of information regarding the carrying capacity of the ranges in various parts of the West has been collected. The fact that intelligent management will bring the ranges back to their primitive state of productiveness has been established. For two years past an area of fenced range in Arizona, in which all types of range land are represented, from absolute desert to good mountain range, has been under careful observation. Two years' protection from stock has sufficed to make this range nearly as productive as it was in its virgin state. The methods of management used by parties who own or control considerable areas of range land are being studied. It is considered to be definitely demonstrated that there is no chance of improving range conditions except where stockmen are enabled to control the ranges upon which their stock feed, and data are being collected which will furnish valuable information as a basis for legislation concerning range lands. It has been demonstrated that a number of species of plants may be introduced upon the ranges by practicable means.

In nearly all cases the plants which have been of value for this purpose are annuals producing large quantities of seed. The possibility of introducing other plants upon the range is still being investigated. In this connection a careful study of the large collection of annual grasses from Europe in our extensive herbarium is being made, with a view to finding species which appear to be adapted to conditions on our Western ranges. Arrangements have been made whereby seed of some of the most promising of the species may be secured for use in the investigations of this subject. It has been demonstrated that in the mountain ranges where there is considerable rainfall a number of standard grasses and clovers may be established upon the range by methods that are entirely practicable. In the mountain region in the State of Washington, by protecting the range from the depredations of nomadic herds of stock, the Bureau has been able to establish such grasses as timothy, redtop, bluegrass, and white clover, thus adding enormously to the productive capacity of these ranges. During the year much assistance has been rendered to ranchers by outlining methods of handling their ranches.

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THE CACTUS AS A FORAGE PLANT.

Much of the range country is covered with a sparse growth of cactus, which for the most part is looked upon by stockmen as a nuisance. During the past year a number of methods have been found by which the cactus plant may be utilized to advantage as stock feed. The value of the more promising species for forage purposes, the length of time required to mature a crop of cactus on land from which the old growth has been harvested, and the feasibility of establishing cactus plantations where they may be needed are now being investigated.

ALKALI-LOVING PLANTS.

The increase of the area of alkali lands in the irrigated districts of the West has given added importance to plants that may be grown upon such lands. Several such plants are available, and the Bureau is investigating the forage value of these plants, as well as methods required for their cultivation. A few years ago the Australian saltbush was shown to be adapted to lands of this character, and a great deal of interest in this plant was aroused among Western farmers. Recent investigations by the Bureau indicate that the cultivation of the plant has practically ceased. There is no question of the value of the Australian saltbush as a forage plant or of its adaptability to strong alkali lands. The principal difficulty with the plant seems to be that proper methods of utilizing it have not been worked out. The Bureau has undertaken to find what place it can be made to occupy in Western agriculture and the methods by which farmers can take advantage of its demonstrated value. Considerable areas of a number of other forage plants known to be adapted to alkaline conditions are being grown with a view to determining their forage value.

INVESTIGATIONS OF GRASSES, FORAGE PLANTS, AND STOCK FEEDING.

The office of Grass and Forage Plant Investigations is now in possession of the varieties of timothy developed by Dr. A. D. Hopkins. Some of these are greatly superior to timothy as ordinarily grown by farmers. They are being propagated with a view to making the seed available, which it is hoped will be within two more years.

Mr. A. B. Leckenby, director of the Eastern Oregon experiment station, has kindly turned over to this office 23 varieties of *Bromus inermis* secured by him during the past two years. These are being grown with a view to rendering the best varieties available for distribution.

The separation into varieties of such standard grasses as redtop, Bermuda, orchard grass, and meadow fescue has been undertaken. Work of this character already done indicates that all of our standard grasses are really mixtures of a large number of established varieties. Some

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of these varieties are much superior to the grasses ordinarily grown. It is hoped within a few years to be able to offer farmers small quantities of seed of improved forms of all the standard grasses.

WEIGHT AND VOLUME OF HAY.

The office of Grass and Forage Plant Investigation has shown that the ordinary rules in vogue for determining the volume of hay in the stack are not reliable, and it has developed formulæ that give reliable results. It is now investigating the number of cubic feet of hay per ton for hay under various conditions as to kind of hay, size of stack, and length of time it has been in stack.

DOMESTICATING NATIVE GRASSES.

A considerable number of native American grasses have shown themselves to be adapted to regions where at present hay grasses are wanting. Several of these are being grown under field conditions during the present season with promise of success. The Bureau is gathering a considerable quantity of seed of other grasses this year and will give them a trial, particularly in the semiarid portions of the West, at the earliest opportunity. It is believed that hay grasses can be found for the Western plains where the average annual rainfall does not exceed 15 inches.

WINTER PASTURES FOR THE SOUTH.

It is estimated that during the past winter one-third of the range stock of some of the ranges in Florida perished for lack of proper nourishment. The winter being severe, losses of range stock were common in all parts of the South. It has been demonstrated that a number of plants can be made to furnish satisfactory pasture throughout the winter months in the South. During the past year a large amount of information concerning these plants and their adaptability to different soils, and the cultural methods required for their successful growth, has been collected. During the present season it is planned to cooperate with Southern experiment stations and Southern farmers in testing a number of these plants for winter pasture purposes.

GULF COAST CROPS.

The agrostologists of the Bureau are studying the forage value of the velvet bean, beggar weed, Mexican clover, and cassava for the region adjacent to the Gulf of Mexico, to which our standard forage crops are not adapted. They have shown that a well-nigh perfect stand of cassava can be obtained by germinating the canes in a cold frame or hotbed before planting them in the field. Heretofore the methods used produced ordinarily not more than half a stand of this crop.

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Methods of keeping cassava canes over winter are still being investigated. These investigations indicate that the most important factor in keeping the canes is maturity. It is extremely difficult to prevent decay of partially matured canes during the winter months. Forty-two varieties of cassava have been secured, one of which last year produced seed in southern Mississippi, although planted nearly two months later than the best planting season. This year one plant was grown from this seed. It seems probable that some of these varieties may be made to thrive considerably farther north than cassava has yet been grown.

FORAGE CROPS FOR SOUTHERN FLORIDA.

The development of truck farming in southern Florida has rendered urgent the need of forage crops for the work-stock used on the truck farms and for the dairy cattle which supply milk to the numerous hotels. Feed for this stock is now shipped long distances at great expense. It appears that Guinea grass and Para grass are adapted to climatic and soil conditions in that section and their possibilities for this purpose are being investigated. Guinea grass seems to possess particular value for hay production, while Para grass appears to be promising as a pasture grass, particularly for wet muck soils. The Bureau is preparing to give them an extended trial.

PACIFIC COAST PROBLEMS.

The office of Grass and Forage Plant Investigations is searching for forage crops to grow in alternation with wheat in order that farmers in the great wheat regions on the Pacific coast may be enabled to secure more than one crop every other year on their fertile lands. A number of grasses are also being studied with reference to their adaptability to dry lands in that section, where there are many thousands of acres of land too dry for any of the standard forage crops.

JOHNSON GRASS.

The agrostologists of the Bureau have demonstrated that the formidable pest known as Johnson grass may be completely destroyed by practicable means and that it may easily be held in check. They are now making demonstrations of the methods developed in their investigations and are endeavoring to devise an implement for removing Johnson grass rootstocks from the soil.

SOILING CROPS.

With the development of stock farming and more intensive methods, particularly in the eastern half of the United States, the practice of soiling is becoming more important. Farm practice with reference to

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soiling crops is being studied with a view to formulating systems for all sections of the country. In this, as in all investigations, the experience of successful farmers has been of great assistance.

CROPS FOR OVERFLOWED LANDS.

The problem of utilizing lands subject to annual overflow has continued to receive attention. Particular attention has been given to short-season annual crops, such as millet, early varieties of corn and sorghum, buckwheat, cowpeas, soy beans, and rape, for lands that are free from water during midsummer and the fall season, and all these crops have been grown successfully on land that was covered with water until the latter part of June. The native grasses which are extensively cut for hay on overflowed and swamp lands are also being studied with a view to making seed of some of the best of them available on the markets, so that farmers who are in need of such grasses may be able to obtain their seed.

FRUIT-MARKETING INVESTIGATIONS.

Next in importance to ability to produce choice fruits is the existence of a sufficient demand for them at prices that will yield a fair profit to the grower. In fact, without reasonable assurance of market demand for the product at fair prices, the planting or maintenance of commercial orchards or vineyards is folly. From the nature of their product, which is at the same time perishable and an article of luxury rather than of absolute necessity to the average consumer, the prosperity of our fruit growers is more dependent upon the price of their product at the time of harvest than that of almost any other agricultural class. Glutted markets at such times are peculiarly disastrous both to individual fruit growers and to the regions in which commercial fruit culture has become an important feature of agriculture.

The avoidance of gluts is, therefore, of very great importance to the entire fruit industry. While many remedies have been suggested, that which appears most practicable and reasonable is the wider distribution of the product. For this reason the chief line of investigation in fruit marketing has been the determination of methods best adapted to the harvesting, packing, storing, and forwarding of fruits to points relatively distant from their places of production, with a view to developing wider demand for them, both in the United States and foreign countries. Chief attention has been thus far given to problems connected with the development of the trans-Atlantic export trade, the most important work having been done with summer and winter apples, peaches, and pears.

While some important points are yet unsettled in connection with these fruits and require the continuation of experimental work upon

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them, some gratifying evidence of the practical value of this line of work appears worthy of notice. The determination of the methods of handling and packing necessary to insure safe delivery of eastern-grown Bartlett pears in European markets during the season of 1902–3 was followed in the fiscal year 1904 by large and profitable shipments of this fruit from Eastern orchards to British markets. While official statistics are not available, it is known through commercial channels that more than 75,000 packages of this variety were thus exported, while the total shipments of Eastern-grown summer and fall pears amounted to at least 165 carloads. While this is but a small proportion of the entire pear crop, its removal from the domestic market was undoubtedly an important factor in maintaining the fair prices that prevailed in our markets during that season, notwithstanding the large crop of that fruit.

Largely through the efforts of the Department, which pointed out the way through experimental shipments which demonstrated the practicability of direct shipments of winter apples to French markets, an encouraging beginning in commercial shipments has resulted. Commercial estimates indicate that during the fiscal year 1904 our direct exportation of apples to France amounted to 200 carloads, which is about twelve times as much as the annual average of the preceding five years. With systematic and judicious continuation of such shipments until consumers become accustomed to American varieties and methods of packing, the French market should rapidly become an important factor in our export apple trade.

The most important experimental export work has been done upon winter apples, as the magnitude of the apple industry warrants first attention. A series of shipments to the principal European markets, in an effort to determine the relative value of the barrel and the box as export packages for this fruit, has disclosed on the whole very little difference in the net results where ordinary "No. 1" fruit was shipped, either with or without paper wrapping. These results are not considered conclusive evidence of the quality of these packages, however, as it is known that in such matters repeated tests are required to insure correct interpretation of results. Increased work along this line will be done during the coming year.

While exact determination of the effect of these investigations on the development of export trade can not be ascertained, it is interesting to note that a comparison of commercial estimates of the crops of the successive seasons with the exports of the corresponding fiscal years shows a steady increase in the proportion of the crop exported, as well as a large increase in the quantity shipped, the proportion exported having risen from less than 1 per cent of the estimated total crop for 1899–1900 to nearly 4¾ per cent in 1903–4, with a total of 2,018,262 barrels, valued at $5,446,473, in the latter year.

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PROGRESS IN FRUIT-STORAGE INVESTIGATIONS.

The cold storage of fruit has grown to large proportions in the last decade, nearly 3 million barrels being cold-stored in the United States last year. When the Bureau began investigations along this line three years ago there was little exact information about the factors which influenced the keeping of fruit. It was popularly supposed that a cold temperature was the most important consideration in successful fruit storage, and that the frequent heavy losses were generally due to unfavorable storage conditions. As a result of the investigations, especially during the past year, it has been demonstrated that the condition in which the fruit is grown and the manner of handling it determine to a large extent the keeping quality as well as the ultimate value of the fruit. Fruit grown to unusual size, like that from rapidly growing young trees, from trees producing a light crop, or from trees forced unduly by tillage or by other orchard treatment, has been shown to deteriorate from one to three months earlier than the same variety grown more slowly.

The investigations are showing that fruit intended for storage must be handled with the utmost care in picking, packing, and shipping, and stored quickly after picking in well-ventilated rooms in a temperature of about 31° to 32° F., if the storage difficulties now most common are to be overcome.

During the past season the Bureau has undertaken to determine what factors cause the frequent losses that occur in shipping perishable fruits, such as peaches, to distant markets. From 5 to 30 per cent of decayed and soft peaches in the top layers of a refrigerator car on arrival at destination from the Southern peach areas is not uncommon, especially in moist, warm weather. Several cars in which the fruit was cooled quickly after picking to about 40° F. were shipped from Georgia to Northern markets. All of this fruit arrived in practically perfect condition, demonstrating that the common practice of loading perishable fruits in a heated condition is one of the important factors in causing serious economic losses. Furthermore, it was demonstrated that the cars could be loaded more heavily with little danger of the fruit in the top of the car deteriorating, and the fruit was harvested and reached the consumer in a riper and better condition on account of the better carrying quality.

In addition to the work outlined, the Bureau is endeavoring to supply the demand for information from fruit growers by determining what cold-storage systems are best adapted to farm use.

There has been a demand for experimental work in fruit marketing and storage from fruit growers on the Pacific coast. The funds available have limited the work to the East up to this time. During the present winter the investigations will be extended to the citrus indus-

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try of California, which in the season of 1903–4 amounted to 30,000 carloads of oranges and lemons. The losses in transit and in warehouses when the warm spring weather sets in are sometimes very large. It is proposed to find out what relation the present methods of picking, packing, handling, and shipping the fruit bear to these losses, in a manner similar to the investigations with deciduous fruits.

That these investigations in fruit storage are having an important influence in improving the commercial methods of handling our fruit products is seen in their growing application by fruit growers, handlers, and warehousemen, all of whom are making demands on the Department for information and for enlarged investigations.

NEW PLANT CREATIONS.

The plant-breeding work, heretofore described, has been continued along a number of new lines. Great advances have been made in the matter of securing new and desirable long-staple cottons. During the last three years a number of long-staple Upland varieties of cotton have been originated, and these have come to be cultivated to some extent in certain parts of the cotton belt, and very generally in the rich bottom lands of the Mississippi and Red rivers in Mississippi, Arkansas, Louisiana, and Texas. A large number of hybrids have been made for the purpose of securing Upland types of long-staple cottons, which can be put into general cultivation, and which will be superior to those now in use. Several of these hybrids are approaching fixity of type. Among these are some having a staple from $1\frac{1}{4}$ to $1\frac{5}{8}$ inches in length.

In the breeding and improvement of corn important advances are being made. The main object of this work has been the selection of strains of corn best adapted to the different sections of the United States. The work is being conducted in cooperation with twenty or more State experiment stations and many farmers. Each year the Department obtains pure seed from the originators and breeders of the leading strains of corn in various sections of the country, and is sending this seed to different localties for comparative tests. At the same time extensive hybridization work is proceeding for the purpose of securing sweeter, more tender, and more productive strains of sweet corn for table use. Connected with this work, also, there are being studied problems relating to the handling of seed corn, seed selection, etc.

Extensive breeding investigations of oats have been carried on, mainly for the purpose of producing a profitable variety for the rich farm lands of the great corn-growing States, where oats are used in rotation with corn. The production of a more desirable oat for meal constitutes a part of this work. Some very promising hybrids have been obtained from the naked oat of China—the so-called "European hull-less oat."

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In the improvement of potatoes important work has been conducted along two lines—(1) type selections, and (2) the production of new seedling varieties. This work was begun in 1902, and already very promising results have been obtained, especially from some of the hybrids.

Some of the most important investigations in the matter of breeding and selection have been inaugurated in connection with the growing of tobacco. This work is conducted along two principal lines—(1) the selection of individual types in the varieties, and (2) crosses between different varieties. Extensive work has been carried on in Connecticut, where both shade and outside tobacco are grown. The work conducted so far has shown unquestionably that the desirable characteristics in the leaf can be fixed from the first year's selection. In this work nine different types have been used and more than 300 selections have been made of each type. One hundred and twenty-five plants are used as a standard for each selection. Thus the work of selection alone has involved the use of something over 40,000 plants.

The work has been conducted in such a way that all the plants have been grown under tent shade, and the entire development of the leaf, from the seed bed to the manufactured product, can be followed. Allied with this work extensive investigations have been made as to the effect of hybridization. Hybrids are easily secured, and from the evidence already obtained by experience in the Connecticut Valley it is believed that the improvement of tobacco by crossing is practicable and can be successfully carried out according to plans now in operation.

Other important lines of work, having for their object the securing of new types of grains, fruits, and other crops, have been carried on. Important work has been done in the matter of developing new varieties of pineapples, new varieties of pears, and other fruits.

PROGRESS IN SEED AND PLANT INTRODUCTION.

The work of introducing and establishing new plants from foreign countries has resulted during the year in the introduction of 1,429 selected kinds of seeds and plants. These have been secured through correspondence and by means of our agricultural explorers, one of whom was sent to the Russian Caucasus in search of new varieties of fruits; one to the West Indies for tropical cassava; a third made an extensive study of the European flax regions, and a fourth visited Mexico in search of southern country apricots. Such a large number of plants, introduced during previous years, remained to be adjusted to American conditions that the efforts this year, more than last, were concentrated on the domestic side of the problems, and no very extensive exploring trips were undertaken. Notwithstanding this, however, a number of new important importations were made. A ship-

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ment of over 350 date suckers, representing 42 varieties, mostly new to America, was made from the oasis of Biskra in the Sahara. Two hundred and seventy samples of different strains of European flax were collected. A collection of 19 selected varieties of grapes from the Russian Caucasus was arranged for. Two hundred and fifty pounds of seeds of the true pistache and smaller quantities of seeds of related species for stocks were imported from Turkey and Central Asia. Thirty-three varieties of mangoes of recognized superiority were secured from Central India in Wardian cases for Florida cultivators.

A shipment of 157 bushels of berseem was made from the valley of the Nile. Two thousand pounds of the famous pedigreed Hanna barley were secured from its originator in Moravia. Two hundred trees of the hardy Vladimir cherry, for trial in the Northwest, were imported from Russia. One hundred and five varieties of French phylloxera-resistant grapevines were secured for trial in infested California vineyards. New species of the lily, from the Philippines and the Neilgherry hills of India, were introduced for breeding purposes. The yang-taw, from Central China, an entirely new fruit-producing vine, was presented to the Department by Consul Wilcox, of Hankow. A number of promising resistant South African grapevines, a collection of Canary Island plants, some East African sorghums, and an interesting clover from Uganda were some of the gifts of Mr. Barbour Lathrop, whose expeditions in search of plants for this Department have been mentioned in previous reports.

Many of the important introductions from previous years still occupy the attention of the office, and either require fresh material from abroad or necessitate field experiments. The durum wheat area has been greatly extended, as already noted. A new date garden in the desert region of southern California has been established in cooperation with the State experiment station. The Egyptian cotton introductions are leading to the production of new hybrid races of promise. The Malin or Moravian horse-radish has proved a success. Japanese bamboo and Mitsumata paper plantations are being arranged for. Tropical mangosteens, imported by post, are being successfully propagated for distribution in Porto Rico and Hawaii. Egyptian clover is being given an extensive trial in Texas, Louisiana, and California. A new seedless pomelo from Siam has been grown for distribution. The Turkestan alfalfa has seeded in several localities, and the securing of American-grown seed of this variety is now a possibility.

CONGRESSIONAL SEED DISTRIBUTION.

As pointed out in my previous reports, constant efforts are being made toward the improvement of methods of securing and handling the general seeds for Congressional distribution. Improved appliances

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have been perfected for the mechanical work, and improved methods have been adopted for securing the seed. The work is now all under the direct supervision of efficient officers of the Bureau of Plant Industry. Every effort is being made to improve the quality of the seed by securing pure stocks. Extensive work is being conducted in the matter of a critical study of varieties under different conditions of soil and climate. Testing gardens for this purpose have been established in a number of localities, and the work is under the supervision of a thoroughly competent expert horticulturist. Every effort is being made to encourage home seed growing. Practically all of the vegetable seed now distributed by the Department is grown in the United States.

A few years ago nearly all of the flower seed, except sweet peas, was imported. Now fully 75 per cent is grown here, through the encouragement offered by the Department in this work. A special effort is put forth in the matter of distributing promising varieties of cotton, tobacco, forage crop, and other seeds. The cotton experts of the Bureau have been constantly at work securing new and desirable sorts wherever they have been found in connection with the other cotton investigations. The results of this continuous distribution of improved strains are already beginning to show in a number of sections of the South.

In the handling of this enormous work which Congress puts upon the Department, the necessity for strict business methods has been fully observed. The work of handling one branch only of this problem involves the securing of more than 25 carloads of special seed, and the testing, packeting, and mailing of this large quantity to all parts of the United States. The systematizing of all the operations has been so perfected that there is little or no friction at the present time.

NITROGEN-FIXING BACTERIA.

Extensive practical tests were made the past season with nitrogen-fixing bacteria for use in connection with leguminous crops. The results have been even more successful than we had anticipated. Hundreds of applications have been sent in from every State in the Union for material with which to inoculate various crops. Practically all of these requests have been complied with in such a way that a record of the results could be obtained. The results show conclusively that where the organisms are used in accordance with the directions issued by the Bureau increased yields, ranging from 15 to 35 per cent, are secured. Furthermore, many farmers have been successful in getting stands of clovers and other crops on soils where failure has resulted heretofore. The several strains of bacteria sent out from the Department have proved valuable even on soils containing the uncultivated

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organisms in abundance. It was discovered during the year that tubercle formation is not necessary to successful inoculation.

The bacteria can be present in the roots of legumes in a very efficient state with no tubercle formation whatever. The material for inoculating an acre of soil by the methods which have been developed costs the Department about 1 cent per acre and the farmer scarcely anything to apply it. So great has become the demand for this material that private concerns have become convinced that there is profit in preparing and distributing it, and several firms are now announcing their preparedness for doing this. Widespread interest in the subject has been manifested by the agricultural press and the magazines, and as a result of this propaganda work the demand for the organisms is constantly increasing.

INVESTIGATION OF PLANTS POISONOUS TO STOCK.

In parts of the Northwest where sheep grazing is an extensive industry, very great losses have been experienced in many sections, due to the so-called "loco disease." This disease is commonly attributed to the eating of the loco weed, by which parts of the range are almost monopolized. In one county in one of the Northwestern States in which sheep grazing has been the chief industry, the disease has made such inroads that many stockmen have been obliged to give up sheep grazing altogether, with the result that land values have depreciated and the sheep from this region are viewed with suspicion by buyers.

During the past two years investigations have been made to test the relation between this devastating trouble and the so-called "loco weed" prevalent in this section of the country.

FIBER PLANTS.

The textile industries using plant fibers have been growing, with increased demand for twine, cordage, and woven goods, but, with the exception of cotton, the production of plant fibers in this country has not kept pace with the consumption. The raw fiber imported during the fiscal year ended June 30, 1904, was valued at more than $47,000,000. This amount included about $9,000,000 worth of cotton, chiefly Egyptian and other grades, not produced here commercially. The other fibers imported were mostly sisal, manila, jute, flax, istle, and hemp. Investigations of all these fibers have been conducted by the Bureau, special attention being given to those likely to succeed in our own country.

DRY-LAND AGRICULTURE.

In my last annual report attention was called to the importance of developing a system of agriculture adapted to the semiarid areas of the United States where general irrigation for ordinary crops is not

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practicable or possible owing to the small annual rainfall and the consequent lack of sufficient water. This is true of nearly one-fourth of the entire arable land surface of this country. It is believed, however, that a profitable system of agriculture can be developed for these areas by securing crops which will grow with a very small amount of water. Considerable progress has been made in this direction and facts have been secured which show the necessity of an immediate and thorough investigation of the conditions affecting the moisture requirements of crop plants for growth in semiarid regions, such as Kafir corn, alfalfa, drought-resistant wheats, and other crops at present unknown to American agriculture.

WATER PURIFICATION INVESTIGATIONS.

Attention was called in my last report to the investigations being carried on by the physiologists of the Bureau of Plant Industry with a view to finding methods of destroying obnoxious algæ in water supplies. The method discovered consists in using extremely dilute solutions of copper sulphate. After a chemical and microscopical study of the water to be treated, and identification of the contaminating organisms, the amount of copper required to be effective is determined and introduced in the form of sulphate. Numerous tests have been made in cooperation with boards of health and water engineers in a number of large reservoirs, and the method has proved remarkably efficient and successful. The fact that one part of copper sulphate to one hundred thousand parts of water will at ordinary temperatures completely destroy the bacteria causing typhoid fever and Asiatic cholera suggests the great usefulness of copper in fighting these diseases and other maladies caused by closely related organisms. Physicians and public health officials have taken great interest in this work, and will doubtless make prompt and thorough tests of the usefulness of copper in such cases.

CONSTRUCTION OF NEW GREENHOUSES.

The new buildings planned for the Department made it necessary to remove the glass houses now on the grounds. A special appropriation of $25,000 was secured for this purpose, and the new houses have been erected and are now complete. This new range consists of 8 modern houses, each 142 feet long, which were put up under contract. Three additional houses have been put up by the Bureau's force of workers, and two of the smaller houses have been moved from their old location to the new one. The new range is much more satisfactory than the old one, and it will be devoted to various lines of work connected with the Bureau. The contract for the new houses was let on June 1, 1904, and they were completed on September 1 of the same year.

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ARLINGTON FARM.

During the year the important work of improving the soil conditions at the Arlington Farm has been continued. New systems of drainage have been put in, cottages for the superintendent and other workers constructed, barns erected, and other improvements made; and the farm has been put in shape for the advanced experimental work it is proposed to conduct there. Extensive plantings have also been made of economic fruits, ornamental trees, and other plants. Test work with potatoes, celery, forage crops, and various fruits has been carried on. Cooperative work with other bureaus has also been inaugurated.

COOPERATION WITH STATE EXPERIMENT STATIONS.

The Bureau of Plant Industry is now cooperating with practically all of the State experiment stations in the country. The work covers investigations of diseases of plants, studies having for their object plant improvement, investigation of forage crop conditions, encouragement in the production of new crops and new industries, and many other lines of work. In some special cases, notably California, close cooperation has been effected, having for its object the establishment of important testing gardens and other allied work. With the assistance of the officers of the California experiment station a testing garden has been established at Chico, Cal. The land for this garden has been donated to the experiment station, to be held in trust by the station for the use of the Bureau.

It is planned to carry on extensive work here in the matter of testing grains, fruits, and other crops specially adapted to the Pacific Coast. It is the policy of the Department in all cooperative work with the stations to fully recognize the relations of the stations to the officers who control them. Furthermore, wherever the Department desires to undertake work in a State, its policy is to endeavor to do this work in cooperation with the station.

FARM MANAGEMENT.

In order to properly conduct the work on farm management, which has already been set forth in previous reports, an office has been established for the purpose. The object of this office is to bring together in systematic shape all of the available information in the Bureau in such a way that it can be placed in the hands of the farmer for his practical use. The office gathers together information concerning farm practice in all sections of the country as a basis for further work. It secures and publishes correct records of crops grown and the manner of growing them, for the information of others who desire to

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follow successful plans. It encourages farmers to visit and study experiment station work, the experiment stations, and the successful farmers in their own section. It encourages diversification in farming where continuous, clean cultivation of a single crop has impoverished the soil. It outlines systems of cropping for different kinds of farming in all sections of the country, and furnishes data in the matter of properly laying out farms, fruit plantations, truck gardens, etc.

BUREAU OF FORESTRY.

PRESENT FOREST SITUATION IN THE UNITED STATES.

The present outlook as regards forestry in the United States is exceedingly hopeful. The lumber industry as a whole is now awakening to the fact that lumbering with reference to future as well as present profits may be good business and ought to be taken into account on business grounds. A growing tendency to hold cut-over lands is plainly marked among far-sighted owners of large holdings. This means that conservative management on the part of those who operate on a large scale is fairly launched. Except that further agitation is essential to give the facts publicity, the general adoption of forestry as an established policy now depends primarily on business conditions pure and simple. The question whether or not it will pay is one to be settled in each individual case by study of conditions on the ground. Forestry can not alter economic conditions; it can only use them. Forestry is now in actual practice on large, privately owned tracts in seven different States. This is the direct result of the past work of this Department in forestry.

FIELDS FOR FUTURE WORK OF THE BUREAU.

NEED OF INVESTIGATING GENERAL FOREST PROBLEMS.

Extensive investigations of forest conditions and of methods of operation are still urgently needed before the road to practical success can be said to be generally open. The employment of foresters by large private owners to supervise operations on their own lands is being taken up. In the public interest this needs to be brought about wherever conditions are favorable, but more and more the promotion of private forestry by the Bureau of Forestry can and should be made incidental to its other functions of directing the management of public forest lands and scientifically investigating general forest problems.

In the case of small owners much remains to be done. The farmers of the country are learning how to get the most out of their land in other ways through the scientific information which the Department of Agriculture collects and diffuses. So, also, in the case of timber yield, studies which individuals can not undertake but which must be

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made if the wealth-producing power of the country as a whole is to be brought to its highest point, need to be prosecuted in the public interest. The average small timber-land owner is to-day in many parts of the country a a decided disadvantage in comparison with the large owner, because he lacks both working capital and equally broad knowledge of general conditions. It is true that large lumbering operations can often be made more profitable than small, but it is not in the public interest that small owners should fail to make a profit which is within their reach because they do not know how best to utilize what they have now, or do not realize what it is likely to be worth in the future. Thus the furtherance of that part of this Department's work which is directed toward informing the small owner how he can to advantage practice forestry on his own account, is of the first importance for the best use of the 200 million acres of woodlots which our country contains.

SCIENTIFIC STUDIES AND AID IN CARE OF STATE AND NATIONAL FORESTS.

By its scientific studies of American forests the Bureau of Forestry has prepared a solid basis for practical forestry. Special studies of our important timber trees have yielded information obtainable in no other way and essential to the management of forests of which they form an important part. There is now no considerable portion of the United States for which the Bureau of Forestry has not at hand special knowledge bearing directly on questions pertaining to the use of the forests. Nevertheless, what has been done is hardly a beginning in comparison with the vastness of the field.

In the work of building up a sound permanent policy for the forests of the National domain the Department of Agriculture has continued to render important services. Much of the work of the Bureau of Forestry during the year has been the examination of lands already reserved or likely to be reserved in order to recommend the exclusion from them of such areas as are more valuable for agriculture than under forest. The personnel of the Bureau of Forestry has become practically familiar, by studies on the ground, with every phase of the question of putting to the best use the public lands of the country. Thus an efficient force has been prepared by actual experience, as well as by technical, scientific training, for the demands which a fully developed National forest policy must eventually impose.

In the light of these facts it is plain that the ultimate function of the Bureau of Forestry as a part of the Government administrative equipment is gradually defining itself. Its effort to introduce forest management among large private owners at the earliest possible moment will cease to be necessary when it becomes generally successful. It was undertaken because of an evident urgent public need. Destructive lumbering had already greatly reduced the area of productive timber

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lands in the United States, and its continuance was a menace to the future prosperity of the country. Because of the work of this Bureau forestry has now a recognized standing in the eyes of the American lumber trade. The Bureau of Forestry is giving a smaller proportion of its time to the preparation of working plans for large timber tracts belonging to private owners than ever before, and bearing a smaller proportion of the expense, and the progress of the past year has brought visibly nearer the time when it can withdraw practically or entirely from this field.

There will then chiefly remain work along the lines of (1) scientific study of problems which have a practical bearing on forest utilization for any purpose; (2) cooperation with States which ask advice concerning forest legislation, administration, or the formulation of a State forest policy, and (3) the discharge of whatever duties may be assigned to it in connection with the administration of the public lands by the National Government.

Along this latter line it is at present the official adviser in technical matters of the Departments which have in charge forested lands under Government control, both here and in the Philippines, and it is also chiefly responsible for recommending changes in present reserve boundaries and for recommending the setting aside of new reserves. The policy which lies at the base of the creation of the reserves is that the public forests should not be withdrawn from use, but should be managed under such restrictions as will insure their permanent usefulness. This policy this Department is actively furthering, and no part of its work is more important.

LINES OF WORK REQUIRING EXTENSION.

An increase in the funds available for the Bureau of Forestry is essential to make it possible to push its work more rapidly. It is my purpose to provide the fullest facilities for the prompt investigation of actual or proposed forest reserves, as well as for further examinations of forested parts of the public domain not now reserved which give promise of permanent value as sources of water or wood supply. The greatest need of the West is water. In many States future settlement and prosperity depend absolutely upon its conservation. This again largely, in many cases wholly, depends on the preservation of the forests. To make possible the execution and extension of the work, I have asked for an increased appropriation for the Bureau of Forestry for the coming year.

PLANTING ON FOREST RESERVES.—The work of planting on forest reserves opens another fruitful field. In the San Gabriel Reserve in California, the Pikes Peak Reserve in Colorado, and the Dismal River Reserve in Nebraska, the planting has been begun and should be vigorously prosecuted. In the first two cases the object is to cover

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denuded mountain slopes with forest growth, in the interest primarily of water conservation and, in the case of the Nebraska reserve, to provide a future valuable timber supply. This planting is undertaken only after a careful preliminary survey has proved that there is an economic need for new growth which nature can not supply, and after painstaking experiment has demonstrated what methods can be depended on for success. Under these circumstances expenditure for planting is as truly economical as is that of the farmer when he purchases seed to sow that he may harvest the increase. I believe that an addition to the sum available for this work will be amply justified by the returns.

The development of economic mining will soon wait for the growth of trees within reasonable distance. The miner is an important factor in the growth of many of our States and of the country at large, and should have all facilities given him to conduct his work on the most economic basis. Where the miner ceases work the farm and factory lose a market. For this reason the miner should have the first claim on the forest for such timbers as he requires.

STUDIES IN FOREST PRODUCTS.—Auxiliary to studies of the forest itself, but of the most importance in relation to the conservative use of our forest resources, stand the studies in forest products. Among them at the present time are (1) the studies in timber preservation, especially of railroad ties, which promise such conspicuous and successful results in timber economy; (2) the experiments in timber testing, to ascertain, under such conditions as obtain in actual everyday practice, new strength determinations for use by engineers, architects, and others; and (3) the investigations of the tannin content of barks, of pulp processes, etc. In the way of securing large economies by a comparatively small outlay for investigation, no more promising field for useful work by the Bureau of Forestry is open than this.

COOPERATION WITH STATE AUTHORITIES.—The desire of State authorities for the assistance of the Bureau of Forestry in cooperative work and in framing forest legislation and their willingness to contribute to its cost are facts worth noting. State cooperative studies have now been made in Maine, New Hampshire, New York, Maryland, Michigan, Wisconsin, California, and Hawaii. Were this Department prepared to push the work along this line large results could be rapidly secured. The whole cause of forest preservation hinges on the interest of the State governments, because no matter how fully persuaded the private owner may be that forest management promises to yield him good returns, without fair assurance of safeguard against fire and of equitable taxation during the period required for a second crop to mature on cut-over lands, he can make no headway. The exclusion of fire depends on local sentiment, State legislation, and State or local police and patrol. Unless the States are awake to their

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duty toward this form of property the Federal Government can do little beyond caring for its own holdings. In California one result of the cooperative work now going on is the drafting of what appears to be the best forest-fire law yet drawn up in this country. The way is now open for a great advance through State cooperation if the requisite means of meeting its cost beyond the State contributions can be made available.

SUCCESS OF FORESTRY WORK.

The successive advances which have been made by Congress of recent years in the appropriation for the Bureau of Forestry offer one of the best evidences of the commendation which its work has received. More and more money has been given to it to spend because it has proved year by year its capacity to do more, and more practical, good work. It prosecutes its researches solely that it may discover and diffuse information which contributes to our National well-being. Within six years its force has increased sixteenfold and its expenditure twelvefold; but neither of these facts is an adequate measure of its advance in practical efficiency or of its success in changing former conditions. By a single discovery—that the cup and gutter system, devised by one of its agents, could be commercially applied to the production of crude turpentine—it is now saving many times more annually to the naval-stores industry than the total expenditures of the Bureau during the whole six years.

It has changed forestry for business returns in the United States from an undemonstrated and doubtful theory into a well-established business operation; it has converted the lumber industry of the country from an attitude of well-grounded suspicion to one of support; it has converted the general public from indifference to what seemed an impractical outcry to an intelligent comprehension of what forestry has to offer. By bringing home to the railroads the need of economic utilization, preservative treatment, and provision for future supplies it has set on foot a movement of incalculable importance. By teaching Western farmers how to plant and grow trees for farm protection and local timber supplies it has added materially to the comfort and prosperity of vast regions and many States. More important still, by demonstrating the capacity of the forest to store water, and by energetic activity to guard from sale or destruction forests of important protective power, it has contributed to the success of National irrigation, one of the most vital developments of recent years.

But though this Bureau has accomplished and is accomplishing practical results out of all proportion to its money expenditure, this is not exceptional in the Department of Agriculture, and forms in itself no justification for a further increase. The question is simply in each case whether the country will be better off by spending the money or

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by not spending it. There are, however, certain special reasons why the Bureau of Forestry should have made, and should for some time continue to make, an exceptionally rapid growth. Its task is virtually that of building up a new science in this country, combined with that of getting its discoveries recognized and applied by a public once little alive to their value. No other branch of agricultural science has recently been in such need of development, and in the whole history of agricultural progress I believe that no other similar development was ever more timely. This development took place because of the unparalleled National need created by the vastness of the interest involved and the critical point which forest destruction had reached. And there is still much to be done before this new science can overtake the nation's requirements.

WORK ACCOMPLISHED DURING THE YEAR.

COOPERATIVE STATE FOREST STUDIES.

Forest studies in cooperation with State or Territorial governments were carried on during the year in New Hampshire, Maryland, Wisconsin, California, and Hawaii. A report on the work in New Hampshire is now in the hands of the printer. It contains a thorough study of the main forest resources of the State, and will afford a satisfactory basis for the adoption of a broad and far-sighted State forest policy.

The study in Hawaii resulted in the publication of a bulletin on "The Forests of the Hawaiian Islands," in the adoption by the Territorial government of its recommendations, and the appointment of a member of the Bureau of Forestry as superintendent of forestry in the islands.

A map and report embodying results of the work in Maryland will appear in the annual report of the State geologist.

In California over 20,000,000 acres of forest were mapped and described; the growth of planted eucalypts was studied; important investigations of the effects of chaparral cover on water conservation and on the forest, and of the forest replacement on denuded areas, were prosecuted; and the study of forest fires was continued, with the result that what is believed to be the best fire law ever prepared for State enactment has been drafted for presentation to the legislature.

FOREST MEASUREMENTS.

Of forest measurements there were handled during the last fiscal year the results of over 24,000 acres of valuation surveys, over 33,000 analyses of trees, 16,000 height measurements, and 2,300 taper measurements. The volume of this work does not, however, measure its importance. In computing, compiling, and digesting the mass of

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information supplied by the field studies of the Bureau the accumulation of details would count for little if the results were worked up by purely routine or mechanical methods. The task imposed is to create a body of scientific knowledge by developing to significant conclusions the raw material turned in—a task calling first of all for intelligence and insight. The result is real advance in accurate knowledge of forest conditions and increasing ability to direct practical operations. Both in the preparation of working plans and in the special studies of commercial trees and forest problems which have been made during the year the efficiency of the work included under forest measurements has been demonstrated.

FOREST MANAGEMENT.

The work of the Bureau under the act of Congress of June 27, 1902, known as the Morris bill, has proved that conservative lumbering under practical regulations pays in the white-pine region of northern Minnesota. In point of fact a higher price was obtained for the timber sold under that act, to be cut and removed under rules prescribed by the Forester, than similar adjacent timber brought shortly before, when sold without such restrictions. On about one-fourth of the 200,000 acres to be lumbered the 5 per cent of timber to be left standing had been selected and marked at the end of the fiscal year.

During the year applications for assistance in introducing forest management on private holdings were received from 47 owners of large tracts, covering nearly 4,000,000 acres, and from 89 owners of woodlots with a total area of about 6,600 acres. The field work for eight working plans for large tracts, covering about 1,000,000 acres, was completed, and for 68 woodlots of nearly 19,000 acres total area.

The eight working plans for large tracts were studies of typical problems in five widely separated States. In Minnesota a tract of land formerly covered mainly with white and Norway pine, a large part of which has been lumbered and is now entirely unproductive, presented a characteristic example of much of the remaining forest land of the lake region. The plan of management devised provides for reproduction from seed trees and for fire protection. In Alabama a working plan was prepared for two forests of virgin longleaf pine, owned by one company, which wished to be assured of a continuous mill supply. In Texas another longleaf-pine study completed during the year furnished the material for estimating present and future yields of longleaf and at the same time demonstrated the wastefulness of some of the lumbering methods now commonly followed.

In West Virginia a tract covered with hardwood, hemlock, and spruce forest, much of which is in poor condition, was studied to ascertain the practicability of management. In New Hampshire three working plans were prepared: one for a tract where the requirement

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was primarily the improvement of a forest-park property; the second for the tract of a manufacturing company wishing to secure a steady supply of box boards and increase the productiveness of the forest; and the third for a White Mountain tract, where the chief requirement was a system of fire protection.

Commercial tree studies of the year included balsam fir, paper birch, poplar, loblolly pine, and red gum.

DENDROLOGY.

Reports which mark the conclusion of the field studies of Missouri swamp forests and Ohio hardwood forests, and of the laboratory studies of gums, resins, tan barks, and pulp-wood fibers conducted in cooperation with the Bureau of Chemistry, were completed during the year. Field work was completed in the studies of California big trees and bristlecone fir, and of turpentine orcharding and laboratory work in a cooperative investigation of turpentine adulterants. A descriptive study of the forests of Suffolk and Nassau counties, Long Island, was begun and finished; investigations of Pacific coast tan-bark trees and of basket-willow culture were continued; and an investigation of methods of turpentine distillation, with special reference to improving commercial processes of production in this country, was begun. Experiments bearing on the culture of the sugar maple were made to supplement a study of the sugar-maple industry previously completed. The collection of forest photographs received notable additions by exchange with foreign countries, and by gifts as well as by the normal increase from the new photographs obtained by the Bureau of Forestry in connection with its field work.

FOREST EXTENSION.

In the work of cooperation with private owners to promote forest planting the Bureau of Forestry prepared during the year 42 planting plans for an aggregate of over 2,800 acres. Altogether 334 planting plans have been made for land in 52 States and Territories. This is a work of high utility, particularly in those regions of the West where timber and water are scarce and farm protection against hot or cold winds is important. Cooperation is confined to the giving of expert advice; all the expense of the planting is borne by the owner. By the adoption of a system of regional studies rapid progress is being made toward a point at which this expert advice can ordinarily be given by correspondence. When this point is reached, the Bureau of Forestry will be in a position to contribute materially to the well-being of wide regions at almost no expense.

In forest-reserve planting extensive operations are now under way in Nebraska, where previous experiments have pointed out how planting on a large scale can be made successful. In the spring of 1904

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there were taken from the nursery and planted in the Dismal River Reserve 300,000 seedlings, of which over 90 per cent survived. Highly efficient and economical methods of doing this work were devised. Preliminary preparations for planting were made in the Niobrara Reserve, Nebraska, the San Gabriel Reserve, California, and the Pikes Peak Reserve, Colorado.

Studies of natural forest replacement were conducted in Colorado, western Kansas, western Nebraska, northern New Mexico, and New England.

The investigation of forest fires, with especial reference to methods of preventing and controlling them, has been continued, and encouraging progress made. The study of the reclamation of shifting sand through forest growth was continued.

FOREST PRODUCTS.

The studies in timber preservation conducted by the Bureau of Forestry are yielding results of large economic importance. Extensive experiments were conducted during the year in the West with longleaf, shortleaf, loblolly, lodgepole, and western yellow pine, spruce, and white and red fir ties. Ties were employed for these tests partly because of the opportunities for experiments of general application afforded by the selection of this form of timber, and partly because of the intrinsic importance of the specific subject of tie preservation. These experiments have already developed a number of important facts connected with timber seasoning and preservation.

In the Central States similar experiments were made with a large number of hardwood timbers, especially with those possibly capable of filling the place for certain uses of white oak and hickory, the supply of which is dwindling fast. It was found that chemical treatment will permit their use for structural purposes; that conspicuous improvement in present methods of seasoning is possible; and that the effectiveness of preservative treatment of red oak is greatly increased by thorough seasoning both before and after treatment.

In the East the seasoning of and application of preservatives to telegraph and telephone poles and cross arms were investigated, and discoveries which render possible considerable economies were made. Further experiments to reduce the rate of decay of poles at the butt are under way. Seasoning experiments are in progress with Adirondack hardwoods.

The investigation of the strength of timbers directly meets the needs of engineers, architects, and others who have to do with the use of construction timber, and is likely to be followed by a revision of specification requirements and grading rules. Large timbers in market forms and sizes, of red fir, western hemlock, and loblolly and longleaf pine

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were tested. Eastern investigations of many species are needed in the interest of the most economical use of our timber supply; for it is undoubtedly true that timber trees neglected hitherto will be found to possess unsuspected value.

Other important lines of investigation pursued were a study of the mechanical properties of red gum, which established, among other things, its suitability for carriage manufacture; studies of the relative strength of various forms of tie fastenings and of devices to prevent the rapid wear of soft timbers protected against decay by preservative treatment; and a study of the effect of moisture content on the strength of timber.

LOUISIANA PURCHASE EXPOSITION FOREST EXHIBIT.

The most extensive and complete forest exhibit ever made by this Bureau was installed at the Exposition at St. Louis. It included the execution out of doors of tree-planting plans and the setting of trees adapted to every part of the country, and an exhibit of the best forest nursery methods. A full exhibit by transparencies, pictures, and apparatus illustrated every phase of our forestry work and forest conditions in all parts of the country. Methods of testing commercial timber were illustrated, and an experimental plant for wood preservation was established and operated during the Fair.

BUREAU OF CHEMISTRY.

The Bureau of Chemistry, during the last few years, has expanded the sphere of its activity in many directions,

AID TO OTHER DEPARTMENTS.

First to be noticed of this expansion is the work done under that authorization by Congress which secures the services of this Bureau for the other Departments of the Government. Under this authority the amount of work which has been done for the other Departments has rapidly increased. This is especially true of chemical determinations in collaboration with the Treasury Department.

For the Department of Justice extensive investigations have been undertaken to determine the injuries suffered by forest reserves from the fumes of smelters. For this Department, also, numerous chemical investigations have been made in connection with cases arising in the administration of justice in the Indian reservations and in certain cases of poisoning which have occurred within those reservations.

For the Post-Office Department extensive examinations have been made of canceling stamps and the inks used therewith; also of alleged remedies offered by advertisements through the mails and regarded by the postal authorities as fraudulent in their nature.

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For the various Departments a large number of analyses have been made of articles offered under contract to determine whether these articles are of the quality and purity specified in the contracts.

FOOD INSPECTION.

The second important item in the expansion of the work of the Bureau of Chemistry has been the establishment of inspection for imported food products. Attention is invited to the fact that under this law the character of food products imported to this country has been greatly improved.

In former years the United States was regarded as the dumping ground for the refuse teas of the commerce of the world. Many years ago, in order to overcome this evil, a system of inspection of imported teas was established and has since been maintained. Under the beneficent working of this system Americans are now certain of being able to purchase pure and wholesome tea, since it is almost impossible for spurious and adulterated teas to find their way into this country. Congress has now extended this system of inspection to all foods, beverages, and condiments imported into the United States. There is every reason to believe that when this system is thoroughly established an improved condition comparable to that which has taken place in teas may be anticipated.

FOOD STANDARDS.

Another important advance which deserves special attention is that relating to standards of purity for food products. The Secretary of Agriculture has been authorized by Congress to fix standards, and in order that they may be just and reasonable he has been authorized to call to his assistance the experts of the Association of Official Agricultural Chemists and other experts, as he may see fit, to advise him in regard to such matters. The work of ascertaining these proper standards, in collaboration with the Association of Official Agricultural Chemists, has been committed to the Bureau of Chemistry. Already considerable progress has been made along this desirable line of investigation and a number of standards of food products have already been fixed by proclamation. It is proposed to extend this useful work until practically all the substances used by our citizens as foods, beverages, and condiments shall have a fixed standard of purity to which all manufacturers may attain by proper care in the preparation of products of this kind.

EXPERIMENTS WITH BORAX IN FOOD.

The work of the Bureau of Chemistry in the study of the effect upon digestion and health exerted by preservatives, coloring matter,

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and other substances added to food has been continued in the same painstaking and thorough manner as in the preceding year. The great quantity of data secured in this work in relation to the effect of borax has been compiled and is now being published. These studies of the effect of borax have led to certain definite conclusions which are of the utmost interest to manufacturers of food products into which borax has often been introduced, and to the consuming public.

The effects of the preservatives upon the functions of the body have been studied in detail. It is admitted that there is a necessity for mineral substances in the blood, as they are essential to the functional activity of the various organs of the body, irrespective of any part they may take in direct nutrition. The necessity, for example, of saline solutions in the blood is known to every physiologist, but it is evident that these saline solutions can be derived from materials of common occurrence and naturally found in food products, or usually added thereto as condiments, such as common salt.

At the same time it must not be forgotten that this does not excuse the introduction of other soluble bodies which have a detrimental effect upon the functional activities, and the excretion of which imposes an additional burden upon the excretory organs. For although such substances might not impair the efficiency of these organs for a number of years, they would finally produce a condition of exhaustion which would be followed by serious consequences.

USE OF SMALL QUANTITIES AS PRESERVATIVE.

The argument that small quantities of deleterious substances may be used without harm is not logical, nor can it be based upon the result of the experiments which have been made. On the other hand, the logical conclusion which seems to follow from the data at our disposal is that the use of boric acid and equivalent amounts of borax should be restricted to those cases where the necessity therefor is clearly manifest, and where it is demonstrable that other methods of food preservation are not applicable, and that without the use of such a preservative the deleterious effects produced by the foods themselves by reason of decomposition would be far greater than could possibly come from the use of the preservative in minimum quantities. In these cases it would also follow, apparently as a matter of public information, and especially for the protection of the young, sick, and debilitated, that each article of food should be plainly labeled and branded, so as to show the character and quantity of the preservative employed.

EFFECT UPON HEALTH OF VARYING AMOUNTS OF BORAX.

The most interesting of the observations which were made during the progress of the experiments was in the study of the direct effect

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upon health of boric acid and borax when administered in food. When boric acid or its equivalent in borax is taken with the food in small quantities, not exceeding half a gram (7½ grains) a day, no notable effects are immediately produced. The medical symptoms of the cases in long-continued exhibitions of small doses, or in large doses extending over a shorter period, show in many instances a manifest tendency to diminish the appetite and to produce a feeling of fullness and uneasiness in the stomach, which in some cases results in nausea, with a very general tendency to produce a sense of fullness in the head, which is often manifested as a dull and persistent headache. In addition to the uneasiness produced in the region of the stomach, there appear in some instances sharp and well-located pains which, however, are not persistent. Although the depression in the weight of the body and some of the other symptoms produced persist in the after periods, there is a uniform tendency manifested after the withdrawal of the preservative toward a recovery from the unpleasant sensations in the stomach and head above mentioned.

The administration of boric acid to the amount of 4 or 5 grams per day, or borax equivalent thereto, continued for some time, results in most cases in loss of appetite and inability to perform work of any kind. In many cases the person becomes ill and unfit for duty. The administration of 3 grams per day produced in many cases the same symptoms, although it appeared that a majority of the men under observation were able to take 3 grams a day for a somewhat protracted period and still perform their duties. They commonly felt injurious effects from the dose, however, and it is certain that the normal man could not long continue to receive 3 grams per day.

In many cases the same results, though less marked, follow the administration of borax to the extent of 2 grams and even of 1 gram per day, although in some of the cases studied the illness following the administration of borax and boric acid in those proportions may be explained by other causes, chiefly la grippe.

The administration of borax and boric acid to the extent of one-half gram per day yielded results markedly different from those obtained with larger quantities of the preservatives. This experiment, conducted as it was for a period of fifty days, was a rather severe test, and it appeared that in some instances a somewhat unfavorable result attended its use. On the whole the results show that one-half gram per day is too much for the normal man to receive regularly. On the other hand, it is evident that the normal man can receive one-half gram per day of boric acid, or of borax expressed in terms of borac acid, for a limited period of time without much danger of impairment of health.

It is, of course, not to be denied that both borax and boric acid are recognized as valuable remedies in medicine. There are certain diseases

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in which these remedies are regularly prescribed, both for internal and external use. The value which they possess in these cases does not seem to have any relation to their use in the healthy organism except when properly prescribed as prophylactics. The fact that any remedy is useful in disease does not appear to logically warrant its use at any other time.

It appears, therefore, that both boric acid and borax, when continuously administered in small doses for a long period or when given in large quantities for a short period, create disturbances of appetite, of digestion, and of health.

TESTING OF ROAD MATERIALS.

The work of the Road Material Laboratory, now the Division of Tests, has been much broadened and its value and importance increased during the past fiscal year. The routine tests on road materials are carried on as usual, and several of the tests have been improved and standardized. The importance of testing rocks to be used in road building is being recognized at the present time by the leading highway engineers of the country, and a number of laboratories modeled after the Department Road Material Laboratory have been established in different places.

STUDY OF CLAYS FOR ROAD MAKING.

Of the 228 samples of road materials reported for the past year, 35 were clays. This is mentioned to show the high percentage which clay bears to the whole number of samples received; for it is a fact not generally recognized that in vast areas throughout the country clay is the only material of which roads can be built. For this reason much time has been spent in studying the physical properties of clays in the endeavor to devise methods by which they can be utilized in road making. It may be mentioned here that up to the present time but one method of using clay in road building has been known—that is, to mix it in the proper proportion with sand. This method, however, is not always practicable, for in many districts sand is difficult to obtain. Many of the Western railroads running through areas of the country where rock ballast was impossible to obtain have been in the habit of burning or clinkering clay with open wood and coal-slack fires along the line of their roads. This clinkered clay has been successfully used for some time past as a railroad ballast.

Many inquiries had been received as to methods of treating roads in some of the Western and Southwestern States, where, owing to absolute lack of hard materials and to the extremely sticky nature of the country clays, many of the farmers were absolutely cut off from the towns during the wet portions of the year. It was apparent that if the local clays could be cheaply burnt to a hard, dense clinker a

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good road material could be provided. Preliminary to actual work on a large scale and expensive experiments on the ground, it was necessary to make laboratory tests of the clays to see whether they would burn to a dense, hard clinker. Samples of the well-known so-called gumbo clay were sent to the laboratory from the Yazoo district of Mississippi. These samples were experimentally burned in the laboratory of the Division, and it seemed quite possible to use the clays in the manner as indicated above.

Following upon this experiment, the Office of Public Road Inquiries built an experimental road in Yazoo City which has been reported successful. It is needless to point out the great importance of the success of such experiments in relation to road building in localities in which no rock is to be had.

IMPORT AND DOMESTIC PRODUCTION OF CLAYS.

Since it is shown by many letters of inquiry that information is being sought by people all over the country on the subject of testing of clays for the various purposes for which they are used, other than road building, special tests are now carried on to that end. A furnace has been installed and actual burning tests on clays are now made. In order to further stimulate interest in the development of native clay bodies, a special circular was issued on "The useful properties of clays." The aim of this circular was to give information in the simplest possible way to people who were not supposed to possess technical knowledge of clays. That the object has been attained is shown by the increased correspondence of the Division on this subject. The circular particularly points out that for the year 1902, the last year for which the official figures are available, the total imports of foreign clays to this country were valued at $1,154,805, while the domestic clays produced were valued at $2,061,072. Since the country possesses unusually fine clay bodies, a great many of which up to the present time await development, any stimulation of interest among the people to develop our native clays must be of great value.

CEMENTING POWER OF ROAD MATERIAL.

The satisfactory investigation of the important property of binding or cementing of road materials when used upon roads has been continued and much new evidence has been obtained.

Under the old rule-of-thumb methods of road building one sort of rock was supposed to be as good as another. Miles and miles of expensive roads have been built in a haphazard way, of any sort of material that was available, and many of such roads have "raveled" and gone to pieces almost as rapidly as they could be built. Since the establishment of the proper methods of testing and investigating these materials, there has been noticed a great improvement of roads. The most

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intelligent and progressive of the State highway engineers are availing themselves of the opportunities extended to them by the Department of Agriculture for studying and familiarizing themselves with the physical properties of the materials which they are about to use before risking the public moneys in expensive work.

The hardness and toughness of a rock which is going to be used on a road are, as everyone knows, important properties, but the property which causes this rock under the influence of traffic to bind or cement together so as to form a smooth, even, impervious shell on the surface of a road is even more important. When the work of the Road Material Laboratory first began the importance of this quality had hardly been recognized, and absolutely nothing was known as to the reason why one rock should possess this property to a very high degree and another of perhaps identically the same name and species should be entirely lacking in it. The closest investigation has been given to this subject and to the collection of all possible data and information, not only from the theoretical and laboratory standpoint, but also from a practical point of view. It is safe to say that its satisfactory solution has been accomplished. A bulletin on "The Cementing Value of Road Materials" has just been published, and the publication of more work in the same line will follow shortly.

A new test for determining the toughness of rock and asphalt mixtures for road building was brought out during the past year, and several new tests are at present being developed.

CONCRETE FOR FENCE POSTS, ROOFS, ETC.

On the 1st of last July the Road Material Laboratory was made a Division, and its name changed to the Division of Tests. The object of this change was to establish in the Department a laboratory where all materials of construction relating to agriculture could be tested and allied problems investigated. In pursuance of this change, several lines of research have been taken up. The first problem selected was to determine whether or not a thoroughly practical concrete fence post reenforced with steel could be made sufficiently cheap to be used by farmers. The advantages of such fence posts would be many. The price of wood, particularly of the varieties used for fence posts, is continually rising, and even now the price is almost prohibitory in some sections of the country. Further, a properly constructed concrete fence post would be permanent, as it would neither rot nor undergo disintegration. A variety of methods of reenforcement have already been tried, and the experiments are being pushed as rapidly as possible. The results so far obtained have been most satisfactory.

Experiments of a similar nature to the above are about to be begun on methods for making concrete drains, watering troughs, roofs, and

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barns, with the hope that concrete construction, so rapidly developing in the large cities, can be applied with benefit to the farm.

The question of the structure and constitution of hydraulic cements is a matter of the very greatest importance. The Division of Tests has in preparation a paper which I have good reason to believe will be accepted as the solution of this much-discussed question.

USE OF OIL ON ROADS.

Much interest has been felt in different parts of the country in the use of oil for treating the surfaces of highways, in order to lay the dust and to offer a hard, impervious, waterproof surface. It is well known that in California such treatment of roads has met with a high degree of success. Similar experiments, however, when carried out in the East, proved complete failures; the Eastern oil failed to bind on the surface of the road, and did not lead to the desired result. When it was found that the main difference between the California natural oils and the Eastern and Texas oils lay in the fact that the California oils contained an asphalt base, while the Eastern oils contained a petroleum or vaseline base, the Division of Tests immediately suggested that the cause of the failure of previous Eastern experiments was directly due to this fact, and road builders throughout the country were urged to make experiments with mixtures of crude oils with crude asphaltum. Last summer the Commissioners of the District of Columbia consented to make such an experiment. A street in Washington was selected for the purpose and a number of mixtures of Southern crude oil and asphaltum were spread in adjacent sections. At first the experiment was looked upon as a failure, but the road has been steadily improving, and at present there is every promise of the experiment proving a success. If it proves true that mixtures of Eastern crude oil and asphaltum make as good roads as the California oils do, a very great advance will be made toward the betterment of our rural highways.

SCHOOL FOR ROAD BUILDING.

One of the chief lines of work for this division during the present year is the establishment of a school of road building. The object of this school is to give a one-year course in highway engineering and the testing of road materials to about four young men who have received degrees from reputable engineering schools. These students are to be selected by a civil-service examination. They will devote six months to the study of road-building problems and road materials and six months to field work, which will consist of actual road construction. Men with such training are sure to be of the greatest service to the country, not only in constructing highways, but in disseminating accurate knowledge on highway construction.

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BUREAU OF SOILS.

The study of soils and their management with regard to their values for producing crops has been continued. The composition of soils varies greatly in different localities and in quite limited areas. Our soils were nearly all fertile originally, but continued cultivation has in many cases reduced their powers to grow crops as they did when first brought under the plow. The best methods of restoring soils that have been cultivated too long is a pressing question not only in the older settled States, but is insistent in most of the newer lands of the West where wheat has been grown until profitable crops of it are no longer to be had.

Rotation of crops and laying down in pastures to be grazed until the soil fills with roots is the well-known restorative, but soils vary greatly in our several States and are adapted to the growth of special crops in our several latitudes, so that a general knowledge of their composition is of prime importance before the tiller can put them to their most profitable uses. Droughts limit the yield on soils that have lost their organic matter through continued cultivation without an adequate return of fertilizers in the shape of decaying vegetation. Commercial manures will not adequately remedy the evil, as they do not return to the soil what enables it to retain moisture. Soils vary so much in this regard, from coarse sand to retentive clay, that each requires careful study to enable the farmer to manage it to the greatest advantage.

The Bureau of Soils is mapping our various areas to the end that the residents on each may as soon as possible learn the peculiarities with which they have to deal. This work is comparatively new. Its value has been overlooked by the educator. A force of soil experts is being trained in the Department to help the cultivator to a better knowledge of the possibilities of his acres throughout our broad land, in order that run-down lands may be reclaimed and that the fertility of our newer lands may be maintained to meet the requirements of a rapidly increasing population.

We are bringing plants from all foreign countries to diversify our industries and enable our husbandmen to grow what has been and still is costing us large amounts of money. A knowledge of the character of the soils from which they come and on which they have been developed is imperative, and suggests to us the wisdom of becoming familiar with the soils as well as the climates to which we introduce them, if we are to maintain them here in their excellence or improve them, giving them better conditions than they had in the countries where we found them. Within the limits of our climates and soils we hope to improve everything we import through a superior aggregation of scientists who are making research into all the conditions of plant life, the soil being of greatest importance.

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PROGRESS OF THE SOIL SURVEY.

The area surveyed and mapped during the fiscal year was 29,058 square miles, or 18,597,120 acres. The area surveyed during the preceding fiscal year was 23,293 square miles, which, together with the work done prior to that time, makes a total area surveyed up to that date of 74,795 square miles, or 47,868,800 acres.

The work was carried on during the past year in 68 areas in 33 States. On an average 20 parties have been working continuously throughout the year, in the Southern States during the fall and winter and in the Northern States during the spring and summer months.

The areas surveyed and the cost of the work in each area are shown in the following table:

Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported.

State or Territory.	Work during 1904.	Work previously reported.	Total area surveyed.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	2,396	1,223	3,619	2,316,160
Arizona	.....	611	611	391,040
Arkansas	626	251	877	561,280
California	1,679	3,921	5,600	3,584,000
Colorado	228	1,345	1,573	1,006,720
Connecticut	.....	518	518	331,520
Delaware	314	.....	314	200,960
Florida	485	548	1,033	661,120
Georgia	853	757	1,610	1,030,400
Idaho	58	1,077	1,135	726,400
Illinois	2,333	3,592	5,925	3,792,000
Indiana	889	387	1,276	816,640
Iowa	1,287	1,016	2,303	1,473,920
Kansas	999	464	1,463	936,320
Kentucky	.....	837	837	535,680
Louisiana	1,446	942	2,388	1,528,320
Maryland	29	2,634	2,663	1,704,320
Massachusetts	386	410	796	509,440
Michigan	517	858	1,375	880,000
Minnesota	.....	233	233	149,120
Mississippi	1,352	1,317	2,669	1,708,160
Missouri	1,111	919	2,030	1,299,200
Montana	.....	107	107	68,480
Nebraska	1,195	.....	1,195	764,800
New Jersey	.....	1,303	1,303	833,920
New Mexico	.....	129	129	82,560
New York	986	1,558	2,544	1,628,160
North Carolina	687	4,646	5,333	3,413,120
North Dakota	386	856	1,242	794,880
Ohio	1,400	1,355	2,755	1,763,200
Oregon	60	386	446	285,440
Pennsylvania	.....	1,204	1,204	770,560
Porto Rico	.....	330	330	211,200
Rhode Island	500	.....	500	320,000
South Carolina	1,159	2,032	3,191	2,042,240

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Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported—Continued.

State or Territory.	Work during 1904.	Work previously reported.	Total area surveyed.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
South Dakota	.....	485	485	310,400
Tennessee	1,596	547	2,143	1,371,520
Texas	2,564	1,733	4,297	2,750,080
Utah	306	994	1,300	832,000
Vermont	227	.....	227	145,280
Virginia	656	2,747	3,403	2,177,920
Washington	.....	510	510	326,400
West Virginia	39	.....	39	24,960
Wisconsin	.....	955	955	611,200
Wyoming	309	.....	309	197,760
Total	29,058	45,737	74,795	47,868,800

RECAPITULATION.

Cost of field work	$64,238.36
Supplies	1,464.18
Traveling expenses between areas	4,115.55
Other expenses	2,783.32
Total cost of soil survey	72,601.41
Paid by State organizations	2,377.57
Paid by Department of Agriculture	70,223.84
Area surveyed ..... square miles	29,058
Cost of work in field per square mile	$2.21
Transportation, supplies, and other expenses, per square mile	.29
Average total cost per square mile	2.50
Average cost to Department of Agriculture per square mile	2.42

The cost of the work in the field has increased from $2.19 per square mile, reported last year, to $2.21 per square mile during the year just closed; while the average cost of the work to the Department of Agriculture, including all transportation, supplies, and office expenses, has decreased from $2.63 per square mile, reported last year, to $2.42 per square mile during the year just ended.

There has been a continued demand for this soil-survey work, and there are on file demands for about two years' work yet unfilled, while requests continue to come in which can not be immediately considered.

There has been a steady demand from colleges, experiment stations, and private enterprises for men trained in this soil-survey work, and during the past year several men have left this Bureau to accept more lucrative positions elsewhere.

PUBLICATION OF THE REPORTS AND MAPS.

At the last session of Congress provision was made to print in the form of "advance sheets" the several reports as they are prepared—500 copies for the use of each Senator from the State, 2,000 copies for the use of each Representative of the Congressional district or districts

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in which the survey is made, and 1,000 copies for the use of the Department of Agriculture. Although this act was passed too late to materially influence the printing of the report of the work for the field season of 1903, it will very greatly facilitate the distribution of the report and is proving a very advantageous way for the printing and distribution of the report of the work for the field season of 1904, the manuscript of the first reports of which have already gone to the Public Printer.

ALKALI-LAND RECLAMATION.

In my last report attention was directed to the important results obtained in the reclamation of alkali soils by underdrainage and surface flooding. This work was undertaken as an object lesson to farmers in those irrigated districts of the West where any considerable trouble had been experienced with the rise of alkali and the consequent depreciation in the value of the land. The results of the past year have again proved the wisdom of inaugurating these demonstration experiments in alkali reclamation. Great interest in the work has been aroused on every side, and frequent inquiries have been received from farmers owning alkali land asking instructions as to the best methods to prevent the further deterioration of their lands and advice as to the reclamation of tracts now partly or wholly unproductive.

On the reclamation tracts established during 1902–3 much progress has been made during the past year, and indications point to the complete reclamation of the lands under experimentation at an early date. On the 40-acre Swan tract, near Salt Lake City, the results have been especially gratifying. At the inception of the work there, in September, 1902, a detailed soil survey showed the first 4 feet of soil over the 40 acres to contain more than 6,650 tons of soluble salts (alkali). In May, 1903, there had been removed in the drainage water, by actual measurement, nearly 50 per cent of this immense total, and in the October following the proportion removed had reached 82 per cent, thus leaving only 1,221 tons of the original 6,650 tons still in the 4-foot section of the entire tract. The greater part of the salt originally in the surface foot had been removed, while even the fourth foot had lost 69 per cent of the alkali originally present.

In the spring of 1904 this tract was sowed to oats, barley, and wheat, as it was believed to be sufficiently sweetened for shallow-rooted crops. The land was not in the best condition for seeding. Nevertheless, on many of the checks 90 per cent of a stand was secured, and on all checks but little evidence of alkali was observed. The flooding process was resumed on those checks having the poorest crop prospects, and will be continued on all the tract after harvest, and by next spring it is expected that reclamation will have progressed to such an extent that the deep-rooted alfalfa can be grown, when the land will be returned

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to the owner. The growing of the crops of the present year and the seeding of the land to alfalfa are under the control of the Utah experiment station in cooperation with the Department.

The progress of a similar work on a 20-acre tract at Fresno, Cal., has been no less gratifying than that at Salt Lake City. The problem here as regards the drainage was more difficult, as the water had to be removed by pumping, while the soil was fine and silty and clogged the drain pipes. These difficulties have been surmounted, however, and within a year it has been possible to grow crops of alfalfa and wheat on a considerable part of the 20 acres under experiment. The Fresno work I deem particularly important, as it is situated in a wealthy district, where large areas of once productive land have been abandoned because of the rise of alkali and the swamping of areas by seepage water from the excessive irrigation of higher lying lands and from the canals.

In the Gervais tract, situated 3 miles from North Yakima, Wash., it is estimated that flooding from July to November, 1903, washed approximately 70 per cent of the total salts out of the soil to a depth of 4 feet. Here, as in the Fresno area, much valuable land has been ruined by seepage water and the rise of black alkali. Flooding of this tract was resumed in 1904, and it is expected that reclamation will have progressed to such an extent that crops can be grown in the coming season.

A more recent experiment has been instituted at Tempe, Ariz., where the installation of the drains was completed in February, 1904. An unprecedentedly dry season and a consequent lack of water have prevented much progress in the work at this point.

Another tract has been taken up for reclamation work near Billings, Mont. This tract is situated in the Yellowstone River Valley, where great progress has been made in growing alfalfa as a winter feed for the cattle and sheep that pasture on the adjoining mountain ranges during the summer. Shortly after irrigation began in this district alkali began to appear and the ground water rose rapidly, waterlogging wide areas of the land to such an extent that its cultivation had to be discontinued. An examination of certain parts of the valley, made by the Bureau of Soils in 1897 and 1898, showed the extent of the damage, and when, in 1902, a detailed soil survey was made around Billings it was found the trouble had greatly increased and intensified. Even in the two years that have elapsed since the survey was made, many fine alfalfa fields have been abandoned and now are heavily incrusted alkali flats. The farmers here are fully alive to the seriousness of the situation, but seem unable to cope with the problem.

Many tracts of land were offered the Department for the purpose of experiment, and a number of farmers have indicated their intention to undertake similar work themselves, showing the interest taken in

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the work. This, however, has not proceeded far enough to permit a full report at this time. I have, however, the fullest confidence in the final success of the undertaking, as well as a firm belief that it will lead to individual or concerted action on the part of those of our citizens most interested, with the result that both the agricultural and stock-raising interests of this part of the country will be greatly benefited.

It seems, then, that within three years, at most, practically worthless land, so heavily charged with injurious salts as to be unfit for any form of agriculture, may be reclaimed to grow any ordinary field crop; that the method of doing this is simple; and that the expense involved is such that the work may in many instances be economically undertaken by individual, corporate, or State initiative. Taking the Utah tract for example, the land reclaimed has increased from a purely nominal value to an actual value, judged by the value of surrounding unaffected lands, of $250 to $300 an acre. The total expense of reclamation, taking everything into consideration, is but a small fraction of this enhanced value.

TOBACCO INVESTIGATIONS.

In the line of tobacco investigations carried on by the Bureau of Soils the most important work during the past fiscal year has been the experimental growing of Cuban seed tobacco on certain soils in Texas, Alabama, and South Carolina. This work was begun in July, 1903, in cooperation with leading farmers in the several States. Thirteen acres were planted in Texas, 3 in Alabama, and 3 in South Carolina. The success of this first trial led to further plantings by the Department in 1904, when trial tracts were established at Nacogdoches, Crockett, and Giddings, in Texas, a total of 12 acres being planted. One tract in Perry County, Ala., and one in Orange County, S. C., were established, each with 3 acres in tobacco. Samples of the tobaccos grown in 1903 were submitted to the trade, and the opinion is that the Texas leaf has considerable merit, both in regard to flavor and aroma, and some have pronounced it to be superior to any filler yet grown in this country. The Alabama filler leaf is considered fair, but not equal to the Texas leaf, while the filler grown in South Carolina does not meet with as much favor as that grown in the two States already mentioned.

The commercial value placed upon this leaf by different tobacco brokers varies considerably, ranging from 18 to 40 cents a pound.

Some bales of Texas leaf have been disposed of at the higher figure. Final judgment of the success of this venture must be postponed until further advices are received from the dealers and manufacturers to whom working samples have been submitted.

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GROWING AND CURING CIGAR TOBACCOS IN OHIO.

Experiments in growing the Cuban type of filler have also been carried on on a 10-acre tract in Ohio. Owing to the heavy nature of the leaf it is impossible to judge of its aroma at present. The tobacco of this type raised in the preceding year is only just ready for the manufacturer. The aroma has been pronounced good, but it is believed that the leaf is too heavy for the taste of the general public and the aim this year is to try to produce a somewhat lighter leaf. The results of these experiments in growing Cuban filler leaf seem to warrant a continuation of the experiments in the Southern States and possibly in Ohio for the succeeding year upon somewhat broader lines; and it is hoped that through the efforts of the Bureau of Soils an extension of the domestic filler leaf interests may be accomplished.

By far the most important work in Ohio, however, has been the further introduction of the bulk method of fermenting cigar tobaccos. This work was begun in 1902, when 655,200 pounds were fermented. In 1903, 4,204,800 pounds were fermented, and in 1904 the quantity was increased to 10,208,000 pounds, distributed among the several types of tobacco as follows: Zimmer Spanish, 5,850,000 pounds; Little Dutch, 582,000 pounds, and seed leaf, 3,776,000 pounds. As the work of the Department there is simply supervisory, and entails the cooperation of the warehousemen, this great increase evidences the remarkable interest that this change in the methods of handling tobacco has to the grower and the tobacco dealer. Its use not only avoids great loss formerly suffered from fungous growth in the case-fermented tobaccos, but also tends to improve the grades of tobacco and therefore increase the profits both to the grower and the handler.

WRAPPER LEAF IN CONNECTICUT.

The experiments in the production of a wrapper leaf in the Connecticut Valley have been continued during the last year. In the beginning of these experiments in 1900, work was undertaken in cooperation with the Connecticut experiment station at Poquonock, on one-third of an acre of land. The tobacco grown on this small plot was submitted to leading leaf dealers and brokers in New York for their opinion. On their judgment, which was very favorable, the Department felt justified in conducting further work in Connecticut upon a considerably larger scale. In 1901, therefore, 40 acres were planted, this time in cooperation with leading tobacco growers in the valley. This tobacco was of satisfactory quality and was sold at Hartford, and although it had been grown under very unsatisfactory climatic conditions a very good price was obtained at the sale. In 1902 a larger acreage was planted by the Connecticut farmers; and leaf dealers of New York—men who had spent their lives in the tobacco trade and

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who were everywhere recognized as good judges of tobacco—invested money in the production of shade-grown tobacco, not upon the reports of the Bureau of Soils, but on their own judgment of the satisfactory character of the leaf.

Owing to unfavorable climatic and adverse trade conditions, which were entirely beyond the control of the grower, the tobacco produced during that season failed, to a certain extent, to meet the demands of the manufacturers. The climatic conditions in 1903 were very similar to those in 1902—that is, they were unfavorable to the production of a wrapper leaf of the very best grade, and there was not so large a demand for this tobacco as was expected. In 1903 the Bureau had practically ceased its work in Connecticut; but in 1904, still having confidence in the opinion of the trade, and believing that the method of growing tobacco for wrappers under shade is correct, it has conducted an experiment at Tariffville, Conn., where a crop has been produced on a 4-acre plat. Owing to the recent tendency on the part of the trade to wrap the better grades of cigars with the Cuban rather than with the Sumatra style of leaf, 1 acre of this plat was planted to Cuban seed tobacco.

Tobacco of this type grown under shade in Connecticut was exhibited by the Department at the Louisiana Purchase Exposition at St. Louis, and to it was awarded the grand prize as being a leaf of the highest standard of excellence for cigar wrappers.

In connection with this matter of the producing of shade-grown wrapper in Connecticut, the Bureau of Soils has been making an investigation as to the demands of the market for the Cuban type of leaf and as to the practicability of building up a demand for Connecticut shade-grown tobacco of this type. Recent sales of this tobacco have been made, principally in New York and Philadelphia, and the following table shows the distribution of nearly 300 bales of such tobacco and the average price per pound of the lots as sold:

Prices received for Connecticut shade-grown tobacco.

For domestic use, 134 bales:			For domestic use, 134 bales—Continued.		
Bales, 17	per pound..	$1.75	Bales, 16	per pound..	$0.62½
1	do....	1.65	4	do....	.35
24	do....	1.50	For export, 144 bales:		
3	do....	1.45	Bales, 14	do....	.70
3	do....	1.40	30	do....	.32½
4	do....	1.35	100	do....	.30
60	do....	1.25	Tops, 104 bales:		
1	do....	1.00	Bales, 90	do....	.10
1	do....	.75	14	do....	.08

This table shows that 134 bales have been sold for domestic use at an average price of $\$1.26\frac{8}{10}$ per pound, the highest price being $1.75 per pound for light wrappers, and the lowest price 35 cents per pound for

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short-sized second-quality leaf. The 144 bales sold for export, at an average price of $0.34\frac{4}{10}$, consisted of tobacco of a quality not suited to the home market, principally of sand leaves and short-sized, flimsy tobacco. Nearly all of this tobacco was shipped to the German market. The 104 bales, sold at an average price of $0.09\frac{7}{10}$, consisted of short top leaves, the tobacco having no wrapper quality, and being useful only as an inferior filler.

The tobacco experts of the Bureau of Soils see no reason to change their belief that the method of growing tobacco under shade in the Connecticut Valley will produce a wrapper leaf of great excellence, which can be economically used by the trade, and it would seem that the industry should be established upon a commercial scale.

IMPROVING EXPORT TOBACCOS.

Up to the beginning of last year the tobacco work of the Bureau of Soils has been along the lines of improving the methods of culture and handling of the cigar tobaccos, but this year considerable demand has been made upon the Bureau to assist the growers of the heavy export types of tobacco. The low percentage of tobacco suitable for plug wrappers, and the poor price obtained by the majority of growers, have led the Bureau to make investigations into the production of this type of tobacco, the object being to see if both the yield per acre and the percentage of the higher grades could be increased. A 5-acre experimental plot in Appomattox County, Va., was selected for studying the problem. In this section the finest plug wrappers are grown, and the work would also be carried on close to the Richmond and Lynchburg markets. It is the plan of these experiments to grow the tobacco with different fertilizers and under different methods of culture, to see which will give the best financial results to the grower. It is the intention of the Bureau to extend this work in the future to other districts producing the shipping types of tobacco. It is yet too early to give the results of the present season's work.

BUREAU OF ENTOMOLOGY.

Insect pests cause a loss to the staple crops of the United States estimated at some $500,000,000 annually. The main object of the Bureau of Entomology is to make thorough studies of the insects responsible for these losses and to apply the information gained to limiting or preventing them. The Mexican cotton boll weevil represents the most important field of work of this Bureau during the last few years, but the insect enemies of the cereals, fruits, and other staple productions have been the subject of careful study and experimental work. The results of this work have been notably successful, particularly in the case of the boll weevil and the bollworm.

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THE MEXICAN COTTON BOLL WEEVIL.

Congress originally provided $30,000 for the continuation of the investigation of the boll weevil and the bollworm for the fiscal year.

DEMONSTRATION FARMS.

Under this appropriation seven experimental farms were organized in Texas, located at Victoria, Wharton, Austin, San Antonio, Calvert, Willspoint, and Hetty, all together aggregating 558 acres of cotton. The seven localities represented typical variations in soil and climatic conditions of Texas, and enabled the Department to test various methods of controlling the boll weevil under different conditions. They included bottom lands, dry upland subject to irrigation, the black prairie land of Austin, and the soils of river valleys where the presence of timber and moist climate and almost exclusive production of cotton renders the weevil problem more serious than elsewhere. Other farms were on the high, rolling prairie land and river bottoms of the northern part of the State.

The minute investigation of the life history of the weevil, upon the knowledge of which any system of control of the pest and any modification of the present cultural system must naturally be based, was continued at the laboratory at Victoria. In the experimental fields attached to this laboratory also were tested poisons and machines. An expert assistant carried on a study of the weevil in Cuba, one of its native regions, with the hope of finding some effective parasite or some variety of cotton especially resistant to its attacks.

The exact spread of the boll weevil into new cotton regions was determined, and a special investigation of the usefulness of birds in controlling the weevil was instituted. The result of the work of the season of 1903 is summarized in three important publications issued by the Bureau.

Under the provisions of the special appropriation of $250,000 made available January 15, 1904, it was possible to greatly enlarge the work.

The number of experimental or demonstration farms was increased to thirteen for the season of 1904, aggregating 1,077 acres. During the previous season in not one of the seven experimental farms then under operation did the crop fall appreciably below the average production in the United States before the weevil came into Texas, namely, about half a bale to the acre. The cultural system which these farms were designed to illustrate has so far proved to be the only practicable means of controlling the boll weevil, and the work of past years has demonstrated its general success and feasibility. It is the outgrowth of several years of field experiments conducted by the Bureau of Entomology in Texas. The cotton on these farms is planted under a contract which gives the Department complete control of the culture of the crop.

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SCIENTIFIC AND LABORATORY WORK.

In addition to the conduct of these demonstration farms, the more purely scientific and laboratory work relating to the study of details of the life history of the weevil and of the possibility of artificial propagation of parasites has been increased. Special work has been done in the attempt to eradicate isolated colonies, to control the danger of dissemination of the weevil by the gins and gin products, notably cotton seed, and the perfecting of quarantine plans to check or prevent the spread of the weevil from Texas to other cotton-growing States.

COOPERATION WITH THE LOUISIANA BOLL WEEVIL COMMISSION.

The weevil having already crossed the line into Louisiana, the Bureau of Entomology has been doing cooperative work with the Louisiana boll weevil commission in eradicating colonies in Louisiana and preventing its further spread into that State, with the idea of protecting not only Louisiana but the more eastern cotton regions. The work of this year has been most successful so far as the experimental farms and other work in Texas are concerned. It has proved impossible to exterminate the weevil in Louisiana, its distribution in the western counties of that State having become already too wide. Nevertheless its spread has been very greatly checked, and by proper quarantine and exterminative work its eastern progress can be very much delayed.

COLONIZATION OF THE GUATEMALAN ANT.

The Guatemalan ant, which was discovered by Mr. O. F. Cook, botanist in charge of investigations in tropical agriculture of the Bureau of Plant Industry, and which seems to be a very efficient enemy of the cotton-boll weevil in Guatemala, has been the subject of careful experimental work, begun under the Bureau of Plant Industry and afterwards transferred to this office, but remaining under the charge of Mr. Cook. This ant, determined by experts of the Bureau of Entomology as *Ectatomma tuberculatum*, is a tropical species of rather wide distribution throughout Central America and northern South America. Its specific habits were unknown prior to its discovery in Guatemala, but in this region, according to Mr. Cook, it seems to be an important natural enemy of the boll weevil. Nearly a hundred colonies of this ant, representing some 4,000 individuals, were conveyed to Texas, and have during the summer been placed at different points, and are being made the subject of careful study to determine whether this ant offers any hope of control to any extent of the boll weevil under the climatic conditions of Texas. The practical results of this importation can not now be foretold. The ant has, however, maintained itself during the summer, which is a feature of distinct encouragement.

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THE BOLL WEEVIL STILL A MENACE.

The future work against the boll weevil in Texas and other Southern States will depend upon the action of Congress. The National menace still exists. The cotton planters of Texas have not all become convinced of the benefit to be derived by following the advice which the Bureau is enabled already to give, based upon its investigations of the past ten years, and therefore further investigation and further demonstration work seem to be necessary. Moreover, the imminent danger of the spread of the weevil to other cotton States indicates the necessity that the General Government should keep a force of men in the field to prove to the entire satisfaction of the planters the value of its advice, to continue the study of the insect in its rapidly changing environment, and to assist in quarantine measures and such other means as are necessary to restrict the spread of the pest.

THE COTTON BOLLWORM.

The work on this insect, which is the second worst pest of the cotton and ranges throughout the cotton belt, has been continued during the last two seasons. The work during the season of 1904 has been much increased as a result of the special appropriation made available in January of this year. The principal lines of investigation followed out are field experiments in methods of control, and laboratory and field investigations of life history, habits, and parasitic and predaceous enemies of the insect. The field experiments have demonstrated that the cultural system of control recommended for the boll weevil furnishes the very best means also against the bollworm. The value of spraying and dusting with arsenical poisons and of trap crops was made the subject of careful experiments. This work was done on six contract farms over which the Department had absolute control, as in the case of the boll weevil, representing different localities and climatic and soil conditions. Cooperative work was also done at a number of other points, giving a total of some 400 acres on which experimental and demonstration work was carried on. The work outlined above has been most successful, and the Department is now able to recommend measures which will reduce damage from the bollworm to an inconsiderable amount.

In addition to these two principal cotton pests, other insects depredating on cotton, but of minor importance in comparison with these two, have been the subject of study.

IMPORTED BENEFICIAL INSECTS.

The possibility of keeping injurious insects in check by the introduction and encouragement of natural insect enemies of such injurious species is a very popular subject with fruit growers and farmers, and

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notable successes have been achieved in this direction. The work in which the Department of Agriculture has been especially interested in this direction during the year has been a continuation of the effort to establish the Asiatic ladybird enemy of the San Jose scale in the Eastern States and the South African black scale parasite in California, together with the kelep or Guatemalan ant enemy of the cotton boll weevil, referred to elsewhere.

The Asiatic ladybird enemy of the San Jose scale (*Chilocorus similis*) maintained itself in numerous colonies in the South during the winter. An examination in Georgia in May last indicated the general presence of the beetle in many of the orchards where it had been liberated. Its rapid multiplication has been prevented, however, in many instances, by the submission of the orchards in question to spraying operations with lime, sulphur, and salt, or other washes, exterminating practically all of the scale food and hence leading to the starvation of many of the beetles. Nevertheless this imported insect has gained foothold and will probably make progress wherever scale food is abundant. Its spread by artificial distribution of colonies has been continued as far as material has been available. The discovery of the efficiency of the lime, sulphur, and salt wash, and the need in commercial orchards of absolutely clean fruit, will operate against this imported insect as against all other parasites of this scale. It is a comparatively easy matter and not expensive to keep an orchard clean by spraying, and while this is the case it will not be advisable in commercial work to take the slower chance of clearing up by natural enemies, which can never be thorough from the very nature of the case. The successful establishment, however, of this Asiatic beetle in America can not work anything but good, as it is an important agency in the control of scale pests, and will become more efficient in America as it becomes more widespread and abundant.

The black-scale parasite in California (*Scutellista cyanea*) has exceeded in usefulness the most sanguine expectations, and has demonstrated that it can withstand the winter climate of California perfectly. The black scale of which it is an enemy is the worst pest of the citrus industry in southern California, and this imported parasite is the first agency which has offered any real hope of control other than by direct spraying or gassing operations. As an illustration of the prolificacy of this parasite, more than 40,000 specimens were distributed from the office of the Los Angeles County horticultural commissioners, and vast numbers were distributed from other centers.

The older importations of beneficial insects, such as the enemy of the white scale of citrous and other fruits in California and the *Rhizobius ventralis*, useful against the black scale in the moist regions of the Pacific coast, have continued their rôle of distinct usefulness, the first named being the most striking case of benefit ever made by an

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imported insect. The fig-fertilizing insect has enabled the raising of another very large and fine crop of Smyrna figs in the vicinity of Fresno, Cal., and the development of the fig industry seems perfectly assured, and only awaits the necessary lapse of time for new orchards to become established.

SCALE INSECTS.

The work with scale insects has been actively prosecuted during the year. This group of insects includes some of the most important enemies of fruit trees and shrubbery, and in the South also of various field and garden crops. The small size of most of these scale insects, and the necessity of making careful microscopic preparations of them before determination can be made, render their identification by field observers difficult, if not impossible. The result is that a great deal of the work of determination comes to this Department from State entomologists and horticulturists, as well as from foreign sources.

INSECTS DAMAGING FORESTS.

The work on tree pests is carried on in cooperation with the Bureau of Forestry. During the present year it has related particularly to (1) insect damage in the forests of the Black Hills region, a continuation of the work begun in 1902; (2) an investigation of important timber trees in the State of Washington, particularly the western hemlock, highland spruce, red fir, and other conifers; (3) at the southern station (Tryon, N. C.), damage to the southern pine and cypress; (4) in the middle Appalachian station, damage to imported mahogany and other timber and lumber by introduced and native insects, and to hickory, oak, and hemlock by bark-beetles and tan-bark insects; (5) at the southwestern station (Flagstaff, Ariz.), damage to pine forests by bark-beetles. In the course of this work there has been considerable cooperation with lumbering companies and manufacturers of articles of wood, importers of exotic woods, and forest rangers. The general information gained from this study and from laboratory work at Washington has greatly advanced the knowledge of forest insects and the means of controlling them.

INSECTS INJURIOUS TO VEGETABLE CROPS AND TO FRUITS.

The work reported in previous years has been continued in these two important fields of investigation. A subject of special study during the year has been the insect enemies of sugar beets, covering work done from Nebraska and Michigan to the Pacific Coast States and Arizona, with the object of issuing a comprehensive report on the subject. Work on the insect enemies of the orchard fruits, citrous and deciduous, and small fruits has been continued. The cranberry insects have been made the subject of a special publication.

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MISCELLANEOUS WORK WITH INSECT PESTS.

A good deal of work has been done during the year in the study of means of controlling damage by insect enemies of stored grains, such as the flour beetles and meal worms, and particularly of the Mediterranean flour moth, one of the worst of mill pests, which has been reported during the year in many new localities, from New York to California.

Insects affecting shade trees and ornamental plants have been studied, as also the important insect enemies of hothouse plants and indoor cultures.

The investigation of insects in relation to the health of man has been continued. The geographical distribution of the yellow-fever mosquito in the United States has been the subject of special investigation, as having an important bearing upon quarantine measures.

A special study has been undertaken of rice insects in South Carolina in cooperation with the South Carolina experiment station.

INSECT ENEMIES OF GRAINS AND FORAGE PLANTS.

An elaborate investigation of insects affecting grains, grasses, and other field crops has been begun, and a special field agent of wide experience and reputation has been put in charge, with assistants and means for the best work. A further investigation will be immediately undertaken of the Hessian fly, the chinch bug, and the cutworms and wireworms and other insects affecting wheat, corn, clover, alfalfa, and similar crops. The damage by insects in this field is greater than in any other on account of the enormous areas under cultivation and the money value of the product.

EXPERIMENTAL WORK WITH INSECTICIDES.

The most important results confirmed by the experimentation of the year with insecticides relate to the use of the lime, sulphur, and salt wash against the San Jose scale. Experimentation with this wash, long used in California against this scale pest, has been going on in the East for several years, and the results now secured have fully demonstrated its very great value in spite of the somewhat adverse climatic conditions which obtain on the Atlantic seaboard and in the Mississippi Valley. It is a winter application, and very inexpensive as compared with the use of oils and soaps, means hitherto very much employed in the East, and it has the additional very distinct advantage of notable value as a fungicide; so much so in fact that some fruit growers are spraying their peach orchards with this wash, whether they have scale on them or not, simply for its value against

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leaf curl and other fungi. The usefulness of this wash has very largely decreased the terror which fruit growers have hitherto felt for the San Jose scale.

The possible value of sulphate of copper as a means of controlling mosquitoes, as indicated in a report issued by the office of Vegetable Pathological and Physiological Investigations of the Bureau of Plant Industry toward the close of the year, caused a series of experiments to be instituted by the Entomologist to test the usefulness of this chemical as a means of destroying such larvæ. The results of these tests have shown that it has comparatively small value against mosquito larvæ under normal outdoor conditions of breeding, but it may prove to be quite effective against mosquitoes in regions where water is kept in cisterns or small storage reservoirs, as, for example, in Cuba and in Panama. The experimentation with this substance is still in progress.

An expert has been put in particular charge of all investigations with insecticides and machinery, and the opportunity for practical work has been very much increased. Experiments are now under way with the insecticides referred to above, and also with petroleum oils; also fumigation experiments on fruit stock and buildings and granaries, and work on the composition of insecticides in cooperation with the Bureau of Chemistry are being carried on.

ENTOMOLOGICAL EXHIBIT AT THE LOUISIANA PURCHASE EXPOSITION.

An elaborate exhibit of the work of the Bureau of Entomology was made during the year for the Louisiana Purchase Exposition—undoubtedly the most extensive and interesting exhibit ever sent out by this Bureau. It contains several entirely novel features of great educational value, and comprises very many cases indicating the life histories of injurious and other insects, together with large models of many of the principal injurious forms and vivaria in which injurious and beneficial insects are shown alive and at work.

SILK CULTURE.

The work in silk culture has been prosecuted in all available lines. Silk reeling has been practically established with imported French reels and the temporary employment of French experts. Several American women have acquired the art of reeling silk, and a beginning has been made in the training of experts in this line of work. The importation of eggs and their distribution to all applicants has been continued; also of mulberry cuttings and rooted plants.

As pointed out in my last report, the establishment of the silk industry in the United States must be a matter of slow accomplishment. The distribution of mulberry cuttings and of silkworm eggs to those

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who already have mulberry trees at hand should be continued. Eventually enough mulberry trees will be planted to insure a supply of food for a large crop of worms. Numbers of people will also have become familiar with the methods of silk raising, and conditions will then be ripe for the establishment of commercial filatures. In the meantime and under the existing conditions the establishment of some sort of market for cocoons is necessary; and it is for this reason that this Bureau, out of its appropriations, is buying and reeling a crop of cocoons which, though small at present, will increase as the work progresses from year to year.

BEE CULTURE.

In bee culture comparative tests have been continued with the Caucasian and other types of bees and various crosses between these types themselves, in an effort to improve the domestic hive bee and secure certain varieties of special merit for different regions. The general conclusion reached is that the Caucasian race is by far the gentlest that has ever been brought to this country, and lends itself to manipulation and handling without the use of bee veil, and generally without smoke. These bees also are excellent honey gatherers.

The frequent statements that comb honey can be artificially manufactured have been shown to be absolutely false, and the purchaser who gets his honey in the comb may rest assured that he is getting an article manipulated at least by bees.

A special investigation has been made of bee conditions over a considerable area comprising the Middle West and Western States, with the idea to familiarize the expert with the conditions in these regions and to determine the feasibility and the desirability of the importation and establishment of foreign honey-producing plants.

A model apiary of 50 or 60 colonies of bees has been secured, and it is proposed to establish it on the Arlington Experimental Farm as a basis for apiarian investigations and as a breeding station of races and types of bees. The importation of foreign queens of different races has been continued, and studies have been made of honey-producing plants, methods of wintering bees, and bee diseases.

BIOLOGICAL SURVEY.

As heretofore, the work of the Biological Survey has been conducted along the three lines laid down by Congress: (1) Investigations relating to the geographic distribution of animals and plants, including biological surveys and the determination of the life and crop belts; (2) investigations of the economic relations of birds to agriculture; (3) supervision of matters relating to game preservation and protection and the importation of foreign birds and animals.

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GEOGRAPHIC DISTRIBUTION.

The Biological Survey is engaged in mapping the natural life zones and crop belts of the country for the primary purpose of aiding the farmer to decide what crops are likely to prove a commercial success in his locality. The work is done by studying the geographic distribution of native animals and plants in all parts of the country, and platting the results on maps showing the distribution of each species. In order to obtain the necessary data the status of the various species must be determined by office study and their ranges laboriously worked out in the field. The progress already made is gratifying, and a large number of maps are now approaching completion. The individual-species maps serve as the basis of a composite map showing the natural transcontinental belts and their more important subdivisions.

During the current year field work has been carried on over wide areas in California, Texas, New Mexico, Colorado, and Alaska. In California the field operations, for the purpose of securing data for a detailed map of the life and crop zones of the State, have been continued under the personal direction of the Chief. The field parties have practically completed work in western Texas, and are now in New Mexico. Explorations in Alaska have been continued among the northern spurs of the Rocky Mountains, about the upper and middle Yukon, and on some of the islands of southeastern Alaska.

ECONOMIC ORNITHOLOGY.

In the section of economic ornithology, as in previous years, both laboratory work and field observations have been carried on. Orchards, gardens, and grain fields have been visited for the purpose of determining whether the birds damage crops, attack injurious insects, or devote their energies mainly to the wild fruits and weed seeds of the neighborhood; and collections have been made of food materials, including wild fruits, berries, seeds, and insects to assist in the work of determination in the laboratory. During the current year examinations have been made of 2,189 bird stomachs.

In studying the food habits of California birds, with reference both to the damage they inflict upon fruit and the good they do in destroying noxious weeds and insects, a scientist spent seven months (February to October) in the State, interviewing many of the fruit growers and visiting the most important fruit-growing sections. Most of his work was in the orchards, where the actual mischief done by the birds was noted and specimens collected.

In cooperation with the University of California, a study was made of the restrictive influences exercised by birds upon the increase of the well-known and very destructive codling moth. As a result, it

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was found that the pupæ of the moth are searched out and fed upon to a considerable extent by the black-headed grosbeak (*Zamelodia melanocephala*) and the Bullock oriole (*Icterus bullocki*)—two of the handsomest and commonest song birds of California. Other investigations were made in the same State regarding the supposed injury done by birds to bee keepers. Examinations of many stomachs of birds shot near bee-hives showed in nearly all cases that if bees are eaten at all the ones selected are the males or drones. A careful study of the food habits of the quail or bobwhite made during the year has demonstrated beyond question that from an economic point of view it is one of the most valuable of North American birds. Some of the insect pests eaten by it are the cotton boll weevil, potato bug, chinch bug, wire-worm, cut-worms of various kinds, and the cotton bollworm.

BIRD MIGRATION.

During the year the usual spring and fall migration schedules were sent to and received from the regular observers and filed for future use. Sixteen thousand notes relating to the migration of warblers north of the Ohio and Potomac rivers were selected and arranged to complete a bulletin on North American warblers. This bulletin is now passing through the press. Work was also commenced on a study of the relations of migration and the weather by comparing the time of spring arrivals with the temperature at the place of arrival and in the region to the southward.

GAME PROTECTION AND INTRODUCTION.

ENTRY OF FOREIGN BIRDS AND ANIMALS.

Constant vigilance is necessary to prevent the introduction into the United States of birds or animals that are likely to become pests. No species, therefore, except a few that are well known and harmless, are allowed to enter this country without a special permit from the Department. And, as an additional safeguard, careful inspection is made whenever through the large size of the consignment or other cause there is any apparent danger that undesirable species may slip in. The permits issued during the year numbered 318 and allowed the entry of 1,470 mammals, 205,400 canaries, and 41,630 miscellaneous birds. Most of the canaries and a large part of the miscellaneous birds came in at New York and were examined by inspectors at that port. Several importations were made of birds intended for liberation, among them 65 capercailzie from Sweden, brought in at New York and destined for the stocking of Algonquin Park, Ontario; 40 Mexican quail, liberated at various points in California by the board of fish commissioners of that State; and 366 European song-birds—

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goldfinches, bullfinches, larks, and robins—turned loose in British Columbia. Permits were also issued for the entry of about 3,000 eggs of partridges and pheasants.

INTERSTATE COMMERCE IN GAME.

Since the passage of the Lacey Act in 1900, 42 convictions for illegal traffic in game have been secured in cases passing through this Department. Of these, 26 were tried in Federal courts, 16 in State courts. During the past year 10 cases, involving the shipment of 700 birds and 36 rabbits, were reported to the Department. Six convictions were secured, one of which involved the longest distance shipment thus far taken up—from St. Paul, Minn., to Portland, Oreg. In order to expedite cases arising under the Lacey Act, State wardens have been advised to present their evidence direct to the Federal courts instead of referring it through this Department and the Department of Justice. This advice has been followed in two or three instances within the past few months, and indictments have been much more promptly secured in consequence.

Limited available resources have, as heretofore, made it necessary to concentrate efforts in two or three areas, and in all cases prevention of shipment has been given precedence over prosecution after shipment has occurred. The passage of laws by Texas in 1903, prohibiting sale and capture of waterfowl, made it possible for the first time to restrict the enormous destruction of ducks in that State for Northern markets. Through local authorities and express companies general attention was called to the provisions of the State and Federal laws and a close watch maintained on usual shipping routes. No violation of the law was noted, and it is probable few consignments of ducks reached Northern markets from this State during the year.

An attempt was made to ascertain the effectiveness of recent legislation prohibiting shipment and sale of game by means of a special investigation in cooperation with State wardens and others. The kinds and prices of game in the markets of a dozen or more important cities during Thanksgiving week were ascertained. That considerable progress has been made in enforcing shipping laws was conclusively shown; few prairie chickens were on sale in any Eastern markets, and in some instances prices three or four times as high as those of a few years ago were charged; pheasants were absent from the markets of several cities where they were formerly abundant; and at the opening of the season quail were unusually scarce, though later, when the routes of shipment still open were discovered by the trade, they became more abundant.

PROTECTION OF GAME IN ALASKA.

The Alaska game law has accomplished the two main objects for which it was enacted: The shipment of deer hides has been stopped

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and the export of heads of big game as trophies has been curtailed. The protection of game has been as satisfactory as could be expected in so large a region and without wardens. A mistaken belief, however, that the law does not permit natives to kill game for food, coupled with objections to the presence of visiting sportsmen, particularly on the Kenai Peninsula, gave rise to considerable criticism of the law. This adverse feeling led to the introduction of a bill in the Senate to replace the present law with one doing away with all restrictions except a provision to limit the export of trophies and charge license fees of $25 to residents and $250 to nonresidents for such export. As the adjournment of Congress without definite action left this measure still pending, the Department deemed it advisable to suspend the issue of permits for the present except in very special cases. Early in June new regulations were issued extending some seasons, permitting unrestricted shipment of bearskins, and making other desirable changes.

MISCELLANEOUS WORK.

A preserve for the elk presented to the Government by Miller and Lux was established in Tulare County, Cal., on the Middle Fork of the Kaweah River, just within the boundary of the Sequoia National Park.

On the Pelican Island reservation in Florida a warden has been maintained through the cooperation of the American Ornithologists' Union and the Department, and the pelicans on the island have been practically undisturbed.

As heretofore, special attention has been given to the duty imposed by the Lacey Act of collecting and disseminating information relating to the propagation, uses, and preservation of birds. The demand for such information is widespread, and much time is devoted to gathering material and preparing it for publication.

RECOMMENDATIONS.

The three distinct lines of work assigned to this Division could be conducted much more economically and effectively were the Division reorganized as a bureau of three divisions, each to have charge of one of these lines, and were a larger amount appropriated for the performance of the work. I have accordingly recommended such reorganization.

BUREAU OF STATISTICS.

On July 1, 1903, the Division of Statistics of this Department, which is the oldest distinctively statistical agency of the Government, antedating by a score of years the creation of this Department, received the broader organization of a bureau.

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As now organized the Bureau of Statistics includes a Division of Domestic Crop Reports, a Division of Foreign Markets, and a Miscellaneous Division, which conducts special investigations and collects statistics on rural economics. The work of the Division of Domestic Crop Reports forms the most conspicuous feature of the statistical work of the Department. It employs nearly two-thirds of the entire clerical force of the Bureau, and calls to its aid the public-spirited service of nearly 250,000 voluntary correspondents, whose painstaking service deserves grateful appreciation. The results of its investigations are published monthly in the Crop Reporter, of which over 1,300,000 copies were distributed during the year.

The general appreciation by the business and farming public of the value of the Department crop reports grows steadily. Criticism is not lacking. On the contrary, it is one of the curious features of this work that the more closely reports represent the actual facts and the wider the appreciation of their accuracy the more subject they become to criticism. This is undoubtedly due to the fact that as their general accuracy is more and more widely recognized they necessarily exercise a greater influence upon the markets, thus inevitably favoring or antagonizing, as the case may be, some of those who are engaged in the game of speculation in agricultural products.

This immediately attracts the adverse comments of the losers. This result is unavoidable, and is apparently the inevitable penalty the Department must pay for issuing reports so reliable and so generally appreciated as to have instant effect on the markets. Were the reverse true, and were these reports regarded as unreliable, they would not influence prices, and criticisms would be reduced to a minimum.

The Bureau is earnestly engaged in studying the efforts of numerous associations of cotton manufacturers organized in several European countries for the purpose of promoting the production of cotton in new lands, with a view to rendering them more or less independent of the American cotton grower. These efforts are being especially directed to the interior of Africa. Before long it is thought that the Department will be able to publish some valuable matter on this interesting subject.

The production and international movement of grain in the principal European countries is another subject which is receiving the earnest attention of the Division of Foreign Markets.

With the assistance of experts newly engaged, the rice and truck crops will for the first time be made the subjects of systematic and continuous statistical investigation. The grain belt has been redistricted and an additional field agent assigned to it.

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OFFICE OF PUBLIC ROAD INQUIRIES.

Popular interest in road improvement appears to be deeper and more widespread than ever before. This is evidenced by the work of improvement actually going on in nearly all sections, by the State road legislation, by the calls for the road literature issued by the Department, and by requests for the advice and cooperation of the Department in building object-lesson roads.

COOPERATIVE FIELD WORK.

For greater convenience and efficiency in carrying on the field work of the Office of Public Road Inquiries the country has been somewhat roughly laid off into four main divisions, with a special agent in each. The work of these and other special agents in the field consists in collecting and disseminating useful information regarding roads and road building, conducting investigations and experiments, attending and addressing meetings, and representing the Department in cooperative object-lesson road work.

At several points in the South the Office of Public Road Inquiries has cooperated in the construction of experimental roads of a mixture of sand and clay, and the results have shown that, in the absence of stone and gravel, this mixture may often be used to great advantage. Other object-lesson roads were constructed, with the cooperation of the Office, in Arkansas, Ohio, Tennessee, Virginia, and West Virginia. These were in most cases first-class macadam roads. An especial effort has been made to keep accurate accounts of the work done in each case, and to report the operations and expenses in such detail as to make the work a source of instruction to all who may read the reports.

Reports from all sections of the country in which experimental and object-lesson roads have been built in previous years are unanimous in commending the character of the work done and testifying to its great influence for good.

It is intended that the work of the Office shall be continued along the present lines of helpfulness and extended so far as practicable, in order that its benefits may be most widely distributed.

STATE ROAD LEGISLATION.

The most important feature in State road legislation of recent years is to be found in the adoption of the State-aid plan. This plan involves a recognition of the fact that road improvement is a matter of general as well as local interest. The inefficiency of the statute labor system of repairing roads, the unwillingness of the rural taxpayers to assume the heavy burdens necessary to the building of improved highways, the popular aversion to the issuance of bonds, and the lack of any

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central authority capable of coordinating the efforts of local communities, have to a great extent paralyzed efforts to secure general improvement of rural highways. The State-aid plan is intended to counteract these depressing influences. It provides sufficient funds to give scope and system to the efforts for road improvement; it distributes the burden of expense so as to greatly relieve the rural taxpayers; and it stimulates action on the part of local communities, coordinates local effort, assures competent supervision, and secures results of permanence and value.

The main features of the State-aid plan as now adopted in a number of the States are (1) a State highway commission, and (2) annual appropriations from the State treasury to pay a fixed part of the expense for building good roads, the balance of the cost to be met by the counties, the towns, and the owners of property lying along the improved roads. In nearly all cases the initiative is with the local communities, and the work is done under local control, but according to plans and specifications which must be approved by the State highway commission.

In New Jersey, the pioneer State in the adoption of this plan, the State pays one-third of the cost and the counties two-thirds, part of the county's share being assessed against the towns, the annual State appropriation being $250,000. In New York the State provides for one-half the expense, while the counties must pay 35 per cent and the towns 15 per cent. In 1903 the legislature appropriated $600,000 as State aid. No two States have adopted exactly the same provisions. Since 1890, eleven States in all have provided for a greater or less degree of State aid. They are the six New England States, New York, New Jersey, Pennsylvania, Delaware, and Maryland. In a number of other States the plan is receiving favorable consideration.

OFFICE OF EXPERIMENT STATIONS.

PROGRESS OF THE EXPERIMENT STATIONS.

The agricultural experiment stations throughout the country are maintaining close relations with this Department and are seeking its cooperation in increasing measure. The Department is endeavoring to aid the stations so far as it can with a view to raising the general level of their work in the directions of scientific accuracy and practical usefulness and to bring the results of their experimental inquiries promptly and effectively to the attention of farmers throughout the United States. It is believed that the Federal funds given to the several States for the maintenance of agricultural experiment stations are now spent more fully for useful agricultural investigations than ever before and that the results obtained by the expenditure of these

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funds, combined with those contributed by a considerable number of the States, will compare very favorably in scientific thoroughness and practical effectiveness with the results obtained with equal expenditures of public funds for similar work elsewhere.

Under the system of State control of the planning and execution of the experimental operations of the State stations and under the liberal terms of the Hatch Act, through which the States are granted Federal funds for the partial maintenance of their stations, there is necessarily considerable diversity of opinion as regards the proper and wise expenditure of these funds. This fact is often overlooked in criticisms of the work of our stations as related to their use of public funds. With the growth of intelligent public opinion in the several States regarding the most useful functions of the experiment stations, the grade of their work has been raised, and when once the local constituency of a station has understood the real purpose and importance of good agricultural investigations, there has been little difficulty in securing the adherence of the managers of that station to the spirit as well as the letter of the laws under which the station is conducted.

ADVICE AND COOPERATION FROM THE DEPARTMENT.

It has been the effort of this Department to set before the stations a high standard of efficiency and to exert steady pressure for the improvement of their work. The cases of clear departure from the law in the use of the public funds granted under the Hatch Act have been comparatively few, and in such cases this Department has insisted on such an adjustment of expenditures as would protect the Federal funds. In most instances of this kind the stations have had funds wholly subject to State authority which could be spent more freely than the Federal funds and so have easily adjusted their accounts to meet the requirements of the Hatch Act. In some cases this has not been practicable and loss of a portion of the Federal fund of the ensuing year has resulted. Not a year passes but that some stations are persuaded by this Department to forego expenditures of the Federal funds which under the terms of the Hatch Act they might technically insist they had a legal right to make but which after discussion they are convinced are not in the best interests of their work. Especially has there been effected a more liberal interpretation of the duties and responsibilities of the agricultural colleges toward the stations, which are organized as departments of research in these institutions. There are now only a few of these colleges where the narrow and short-sighted policy of dealing illiberally with the experiment stations is maintained, and this Department will not cease its efforts to bring about a change of view and action by such college authorities on this important matter.

As the amount and variety of the cooperation between the bureaus of this Department and the State experiment stations increase there

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arise from time to time questions of policy regarding the relations of the Department and the stations in such enterprises. To provide a regular agency for the discussion and adjustment of such matters, I have created during the past year a standing committee on cooperation, consisting of the Director of the Office of Experiment Stations and the Chiefs of the Bureaus of Plant Industry and Soils. Several conferences have already taken place between this committee and the executive committee of the Association of American Agricultural Colleges and Experiment Stations.

During the past year a movement looking to the increase of the funds granted by Congress for the use of the experiment stations has been inaugurated and legislation for this purpose is now pending. After a careful study of this matter in connection with the examination of the work and expenditures of the stations during the past two years, I am convinced that the demands on the stations for the extension of their work which have been aroused by their success in giving direct practical benefits to agriculture in all parts of the country can not be met without increased funds and that they are in a position to make effective use of larger means than they now have at their command. Now that this matter is being publicly discussed and the details of legislation have not been decided, it seems proper to state that in the view of this Department it is highly important that in any further act which Congress may pass for the benefit of the agricultural experiment stations the Federal funds shall be explicitly granted for purposes of agricultural research, and the powers and duties of this Department as related to the supervision of those funds shall be clearly defined.

STUDIES IN CHEESE MAKING.

As the work of the experiment stations advances from year to year experimental data accumulate in many lines, and from time to time results of great general importance come out of this extensive work. A good example of this at the present time is found in the investigations of the stations relating to cheese making. The importance of this in this country is shown by the fact that cheese production now amounts to 300,000,000 pounds a year, valued at approximately $30,000,000. Though cheese making is probably the oldest dairy industry, very little has been known regarding the principles on which it is based. For centuries it has been carried on largely by rule-of-thumb methods, and the reasons for the various processes and the exact nature of the changes brought about by them have been unknown to the cheese maker. He has been guided mainly by the traditions of his art and has depended upon the skill and judgment acquired through long experience.

Within the past ten years several of the experiment stations of this country have prosecuted systematic studies of cheese making with a

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view of determining the principles upon which it rests and the means of simplifying and improving its processes. Owing to the large number of factors involved the work has been difficult, and for a considerable time the progress was slow. Now, however, the accumulated results are of great practical value, and it may be fairly claimed not only that this great industry has been put on a rational basis, but also that the art of cheese making has been simplified and its processes can now be more easily controlled, so that good cheese can be more uniformly produced.

GAINS IN USE OF FEEDING STUFFS.

The Office of Experiment Stations has recently published a summary of a large amount of work which the stations have done on questions relating to feeding stuffs. Some of the practical results of this work have been very important. The saving and use of corn fodder (stover), which was formerly so largely wasted over a large part of the country, is a striking illustration of this. Its value as a feeding stuff has been demonstrated, and the best means of utilizing it have been shown by the stations' work, and their continual agitation has brought about very great improvement in farm practice in this respect. At the nominal value of $1 a ton the corn stover crop of the United States would be worth at least $100,000,000. While it is not all utilized, much the larger share of it is, and the practice of doing this is steadily increasing.

The inspection of commercial and condimental feeding stuffs, brought about by the experiment stations, has already had the effect of largely holding in check the adulteration of these products and fraud in their sale. In a number of the States where the laws have been vigorously enforced by the stations inferior articles have been entirely driven out of the market, because farmers would not buy them unless they received the stations' stamp of approval.

THE AGRICULTURAL COLLEGES.

The activity of the colleges in providing special buildings and laboratories for instruction in the different divisions of the science of agriculture continues unabated. Among the buildings of this nature recently completed are the $50,000 agricultural building in South Carolina, the $150,000 agricultural building of the University of Wisconsin, and the agronomy and animal husbandry judging pavilion and the farm mechanics building of the Iowa State College of Agriculture and the Mechanic Arts. The University of Nebraska is erecting a $60,000 building for its school of agriculture.

The appropriations of the year for new buildings at the colleges and for the maintenance of these institutions have also been very large. The State legislature of Virginia appropriated $165,000 for buildings,

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equipment, and improvements at the agricultural college. The Iowa college has an addition of $50,000 to its maintenance fund, an appropriation of $95,000 to complete the central building, $45,000 for a dairy building, and $10,000 for equipping it, $22,000 for a new dairy farm, and $7,000 for equipment, and $54,500 to begin the construction of a heating plant, with several minor items, including $15,000 annually for the experiment station. The College of Agriculture of Cornell University is now definitely organized under State support, with an appropriation of $250,000 for buildings and equipment. The Illinois College of Agriculture has appropriations for a building for beef cattle, $25,000; another for horticulture, $12,200, and for a storage building for agronomy, $12,500. Minnesota has appropriations aggregating $300,000 for building purposes, including, among other items, $218,000 for a main agricultural building.

There is increasing interest in the formulation of courses in rural engineering and the provision of special facilities for instruction in this important subject. Special attention is being given to instruction relating to the construction and use of farm machinery. The continued scarcity of farm labor in almost all of the agricultural regions in this country makes necessary the employment of farm machinery on even a more extensive scale than has hitherto prevailed. The total value of implements and machinery on farms in this country, according to the last census, was $761,261,500, an average of $133 per farm and of 90 cents per acre of farm land. Much of this machinery is elaborate and complicated in construction and requires mechanical skill and genius for its most efficient operation and care. In very many cases it is also essential that the farmer shall understand how to repair such machinery. It represents an important part of the farmer's invested capital upon which he must earn or pay interest. That there is an enormous waste of money due to neglect and unskillful handling of this part of the farm equipment must be obvious to any one who has traveled through the regions where it is most used. The colleges can therefore do a very important work in training their students so that they will understand the construction, care, and most economical use of farm machinery.

The attendance at the land-grant colleges in 1903 aggregated 52,489 students, of whom 3,146 were in four-year courses in agriculture, and 7,550 in shorter courses in agriculture, dairying, horticulture, and veterinary science. The graduates of these institutions in 1903 were 4,524, and since their organization 53,252. The importance of the colleges of agriculture and mechanic arts as a part of the American system of higher education and research has been notably shown during the past year at the Louisiana Purchase Exposition, where an extensive exhibit of the work of these institutions was made in the Palace of Education.

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SECONDARY AND ELEMENTARY SCHOOLS.

Progress has been made during the year along the lines of secondary instruction in agriculture not only in the schools maintained in connection with the agricultural colleges, but also in separate secondary schools, the number of which is steadily increasing. Considerable attention is being given of late to the practical instruction of women along agricultural and horticultural lines.

The introduction of agricultural instruction into the primary schools is being more widely discussed than ever before at meetings of teachers and farmers. The success of the nature study and school garden movement in a considerable number of city and country schools has led to a demand for the more formal teaching of elementary agriculture in the higher grades of the rural schools. The National Educational Association, State superintendents of public instruction, officers of agricultural colleges, as well as a number of other organizations and numerous individuals in various official positions, have of late interested themselves in the introduction of elementary agriculture and gardening in these schools. The National Educational Association now has a special committee of educators of national repute considering this subject.

METHODS AND TEXT-BOOKS.

At the recent convention of the Association of American Agricultural Colleges and Experiment Stations at Des Moines, Iowa, the standing committee on methods of teaching agriculture made a report in which it gave a brief history of the development of manual training and agricultural instruction in the common schools, and outlined a course of nature study and elementary agriculture for such schools. Outline courses in elementary agriculture have already been prepared by school officers in a number of States. These are supplemented by the formation of clubs of farmers' boys and girls, which are organized for the purpose of conducting simple experiments at their homes. Eight thousand Illinois boys belonging to these clubs exhibited corn of their own raising at the Louisiana Purchase Exposition. In a number of States laws have been enacted requiring teachers to pass examinations in agriculture, and the training of teachers along agricultural lines is already receiving considerable attention at agricultural colleges and schools, and normal schools, especially at sessions held during the summer. A considerable impetus to the movement for the introduction of agriculture in the public schools has been given by the recent improvement of text-books and works of reference. Within the last year or two a number of elementary text-books in agriculture have been published, and some of these seem well suited to use in the rural schools. In one way or another thousands of children in the

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common schools are already receiving some instruction relating to agriculture, and the movement in this direction is rapidly increasing.

AID FROM THE DEPARTMENT.

This Department is aiding this movement so far as it can without having funds specifically for this purpose. It seems very desirable that the Department should be in a position to give more effective aid to the movement which contemplates the application of the results of practical and scientific investigations to our agriculture through instruction to multitudes of farmers' children in the public schools as well as in the agricultural colleges. The vast majority of teachers in rural schools throughout the country are unacquainted with the work and publications of this Department and do not understand how these publications might be utilized for instruction in subjects related to agriculture. Very much needs to be done to overcome the prejudice of school officers and teachers against the introduction of agricultural subjects into the schools. It is becoming increasingly clear that the results of the work of this Department and the experiment stations can not be most effectively and widely utilized by our farmers unless in early life they are taught to think and act along the lines in which the application of scientific principles and discoveries is made to appear theoretically rational as well as practically useful. Therefore, to secure the greatest benefit to our agricultural people through the expenditure of public funds in the maintenance of this Department and the experiment stations, we should be able to bring the work of these institutions directly to the attention of our educators and school managers in every State and Territory.

FARMERS' INSTITUTES.

Work in the interests of the farmers' institutes throughout the country has been regularly organized in the Office of Experiment Stations. Special efforts are being made to aid the large force of lecturers who are in the employ of the State directors of institutes. The attention of these lecturers has been definitely called to the numerous publications which this Department and the experiment stations are issuing, which will be useful to them in their institute work, and they have been put in the way of receiving these publications regularly.

There is also a growing movement for the establishment of the institutes in the several States on a more permanent basis. The form of organization most approved is that of a strong local permanent organization in each institute district, combined with a system of oversight and limited control by the central State authority, whose duties and powers are prescribed by law.

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ALASKA EXPERIMENT STATIONS.

During the past year experiment stations were maintained at Sitka, Kenai, Rampart, and Copper Center, and cooperative experiments were conducted at Wood Island. Seeds of vegetables and flowers were distributed through the cooperation of the Bureau of Plant Industry to about 1,500 addresses. Many of the recipients report success and further confirm the possibility of raising hardy vegetables and hardy annual flowers in nearly all parts of the Territory south of the Arctic Circle. An investigation of the grasses and forage plants of Alaska is being conducted in connection with the Bureau of Plant Industry. At Sitka the headquarters building has been completed in accordance with the plans furnished by this Department, except for some minor alterations made in the interests of economy. More attention will hereafter be given at this station to horticulture and the propagation of trees and bushes for distribution to the other stations and over the Territory at large. Some nursery stock consisting of hardy and early maturing varieties of apples, plums, and cherries have been planted, and currants, gooseberries, and raspberries are also being propagated.

SOME RESULTS OF THE WORK AT THE STATIONS.

At the Kenai station about 21 acres have been brought under cultivation. Experience during the past two seasons at this point has shown that the maturing of grain is somewhat uncertain, though an abundance of forage can be grown every year. Cattle do well here, and the station is beginning in a small way to build up a herd.

At the Copper River Valley station, opened two years ago, a number of acres have been cleared and cultivated. During the season of 1903 barley and oats matured, and produced plump and heavy grain. Cultivated grasses seeded in experimental plats did well, and a considerable variety of hardy vegetables were grown. In 1904 an elaborate system of plants has been laid out and extensive experiments are under way with cereals. During August a severe frost destroyed many varieties of the cereals, rendering them fit only for hay, but some barley was matured and the grain saved for seed, and about 90 per cent of the Sixty Day and Finnish Black oats were matured, making about an average crop. This station has the first equipment of farm implements brought into the interior of Alaska. A number of small tracts have been cleared by settlers and are under cultivation at various points throughout the valley.

At the Rampart station grain matured in 1902 and 1903, and for this reason more extensive experiments have been conducted during the past year, and barley, oats, and rye have been successfully grown.

In general the experimental work in Alaska has shown that live

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stock may be successfully maintained at many points in the Territory. The special agent in charge of the Alaska stations urges the desirability of securing breeds of sheep and cattle better adapted to the climate of Alaska than those which have hitherto been maintained there. It is, however, impracticable to carry on experiments with animals in any large way with the present funds at the disposal of the stations.

GRASS LANDS AND LIVE STOCK.

There are on the southern coast of Alaska, from Cook Inlet to Unalaska, about 10,000 square miles of grass lands, over one-half of which are capable of utilization. On much of this land there is a luxuriant growth of grasses often 6 feet high; on the remainder, lying at higher elevations and in more exposed situations, the grasses are too short for hay cutting, but furnish splendid pasturage. That these grasses are nutritious the fat and sleek condition of the cattle furnishes ocular demonstration.

At the present time this great resource is practically untouched, though there are small herds of milch cows at most of the towns and villages. Recently a live-stock company has begun operations with cattle and sheep on Kodiak Island and another company is making actual preparations to utilize Akutan Island.

It is possible for both sheep and cattle to live throughout the winter without care, as has often been demonstrated. Indeed, where cows belong to the natives they are forced to live through the winter with little or no care, eking out an existence by feeding on browse and seaweeds. Milch cows kept by whites are as a rule fed from five to six months, and this may fairly be considered the length of time when animals require feed and shelter.

Sheep raising has thus far not proved successful. The principal trouble seems to have been that the animals were of breeds not adapted to the conditions that prevail on the Alaska coast. In both cases where trials have been made grade animals were imported from the semiarid regions of California and Oregon, where the climate is wellnigh the antithesis of that in Alaska. With other breeds success is not at all unlikely to follow.

For three reasons I am impelled to believe that the Alaska grass lands as a whole can be most profitably utilized at present through dairying. First, because the small population of the Alaska coast limits the market for beef to a small fraction of the possible yield. Second, because of the necessarily long feeding period, five or six months, during which only dairy cattle will yield compensating returns. Third, because the freight to distant markets on concentrated products like butter and cheese is not a serious factor.

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The Alaska coast furnishes many admirable sites for dairy colonies or settlements, both on the islands and on the mainland. With such a great wealth of grass as southwestern Alaska possesses it is difficult to believe that it will not become a great dairy country. It is doubtful if equally good opportunities for colonies of dairymen can be found in the United States to-day. Certainly there is no other place left where 320-acre homesteads of magnificent grass lands can be had for the taking. In view of the enormous area of these lands, it seems most advisable that this undeveloped resource be converted into wealth. Perhaps nothing will stimulate this as much as practical experiments and demonstrations by the Department of Agriculture.

HAWAII EXPERIMENT STATION.

A chemist and horticulturist have been added to the staff of the Hawaii station, and in this way the field of operations has been considerably widened. Soil investigations have been undertaken by the chemist, which are of general importance to the agriculture of the islands. The horticulturist has prepared a bulletin on bananas, which not only treats of the cultivation and marketing of this fruit, but also brings together descriptions of a large number of Hawaiian varieties, making possible a systematic study of this important food plant. Experiments are being continued on the cultivation and fertilization of bananas, and a large collection of varieties is being brought together on the station grounds. Experiments in the propagation of mangoes and alligator pears have been begun.

The entomologist has prepared a bulletin on the leaf hopper of sugar cane, which was investigated at the solicitation of many of the planters of the islands. This insect made its appearance quite recently and has proved in certain districts to be a very serious enemy to cane cultivation. The bulletin treats of the life history of the pest, describes the injury produced, and offers suggestions for its control.

Under the immediate direction of the special agent in charge, investigations have been made of some of the fungous diseases of coffee, sugar cane, and other economic plants, and a comparative test of grasses and forage plants has been begun in connection with the Hawaii Live Stock Breeders' Association. Cooperative experiments with tobacco hav been conducted on the island of Hawaii with the object of producing a type of tobacco that is especially adapted to Hawaiian conditions. Cooperative experiments on cacao and banana cultivation are also being carried on in connection with the insular board of agriculture and the Hilo boarding school.

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PORTO RICO EXPERIMENT STATION.

The work of the Porto Rico experiment station has been considerably enlarged during the past year, partly with the aid of an appropriation of $2,700 made by the insular legislature and nearly $1,200 received from the sale of farm products.

Many permanent improvements have been made on the station farm. A small tile machine was purchased and drain pipes were manufactured on the farm. Practically all the river bottom or alluvial land on the station farm has been drained. This is the first underdrainage ever undertaken in Porto Rico, and it is believed that it will not only greatly enhance the producing power of the station property, but will also serve as a valuable object lesson to the planters of the island. An experimental irrigation system has also been installed on this farm.

A preliminary survey of the principal tobacco districts of the island has been made by a tobacco specialist in the employ of the station, and a report on these investigations is being prepared.

The investigations on different methods of pruning, shading, and fertilizing coffee plants have been continued. An attempt to exterminate the coffee-leaf miner by hand picking the leaves proved the impracticability of this method of repressing this pest. The entomologist of the station has also been investigating the possibility of combating this insect by means of parasites, and reports the discovery of an effective parasite which, it is believed, by careful propagation and distribution, will aid very materially in keeping in check this insect, which is by far the most serious enemy to coffee cultivation now upon the island.

A special study of the diseases of coffee and other plants was made by the botanist of the Connecticut State experiment station, who was temporarily in the employ of the Porto Rico station.

Much attention is being given to the propagation of citrous fruits, especially with a view of obtaining better stock for growing in the orchards of Porto Rico. A bulletin on the methods of production and marketing of oranges, with special reference to Porto Rico conditions, has recently been issued. A large number of tropical fruits, including mango, alligator pear, soursop, nispero, guava, and many others, have been brought together in a tropical fruit orchard.

The tea, rubber, and cacao plantations mentioned in my last report are flourishing and are being extended. Among the tropical vegetables which enter into the variety tests are the yautia, taro, edible canna, arrowroot, cassava, yams, and sweet potatoes, all of which have thus far done well.

Experiments are being carried on with a number of fiber plants. Among these, maguey and sisal have thus far given very promising

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results. The station has thus far conducted no careful experiments with cotton, but the industry has been extended throughout the island to a considerable extent during the past year, and the station officers report that the results seem to indicate that it is possible to profitably produce a medium grade of Sea Island cotton in Porto Rico.

The report of the Bureau of Soils on the soil survey from Arecibo to Ponce, made by that Bureau in cooperation with the Porto Rico station, has been reprinted in both English and Spanish for distribution on the island. Several other bulletins and circulars in both languages have been issued during the year.

PROPOSED EXPERIMENT STATION AT GUAM.

This Department has recently received a request from the governor of Guam for the establishment of an agricultural experiment station on that island. In making this request the governor states that the population of the island, consisting of about 11,000 people, and increasing at the rate of about 3 per cent a year since the American occupation, is devoted entirely to agriculture. The farms, which are small, are located in the hills back of the surrounding towns, and the people usually go to them in the early morning, returning to their domiciles at night. As they are devoted to tilling the ground and the raising of fruits, and to nothing else, this is an especially good field for the introduction of such additional fruits and vegetables as only the resources of the Government can command. The revenues of the island are insignificant, so that the people can not afford to pay anything toward an experiment station, although its influence will be very beneficial. There is a considerable tract in the public lands of the island which could be set aside for an experimental farm.

Since it seems quite important that the people of Guam should receive such aid in developing their agriculture as is now given by the Government to our other island possessions, I have recommended an appropriation of $5,000 for the maintenance of a station on this island in cooperation with the Navy Department.

NUTRITION INVESTIGATIONS.

In the nutrition investigations steady progress has been made in the elaborate and fundamental inquiries regarding the laws of human nutrition with the respiration calorimeter, and in the more directly practical studies of the nutritive value of cereals, fruits, and meat. The great importance of these investigations is being recognized, not only by scientific and educational institutions throughout this country, but also in many foreign countries. The constantly increasing number of requests for nutrition publications and for information from individuals, institutions, public schools, medical schools, and similar

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sources, is a proof that the results of the nutrition investigations excite wide interest and are appreciated.

The cooperative method by which the work of investigation has been distributed among various educational, scientific, and similar institutions in the United States has been productive of as excellent results the past year as hitherto, and a satisfactory amount of investigation has been conducted. This has been made possible in part by the generous support accorded by the cooperating institutions, which have contributed in some cases money, and in practically all cases the use of laboratories, apparatus, libraries, the advice and counsel of skilled experts, and similar assistance. Other institutions have expressed a readiness to join in such researches, provided a comparatively small amount can be allotted them, but with the funds at our command it has not been found possible to extend the inquiry beyond the present limits.

CALORIMETER EXPERIMENTS.

The experiments with the respiration calorimeter during the past year have had to do principally with the comparative values of fat and carbohydrates as sources of energy. The apparatus has been so modified that a given quantity of air is circulated through the respiration chamber, the oxygen withdrawn by the subject being made good by the addition of a fresh supply, while the products of respiration are removed for measurement and analysis. This method of experimenting permits of direct measurements of the oxygen consumption in addition to other factors concerned with the metabolism of matter and energy, and represents a decided advance. In its present form the apparatus is fully as accurate as the form previously described and gives very satisfactory results. The form of apparatus which may be most advantageously used depends upon the character of the problem which is to be studied, since both the earlier type, in which a continuous quantity of air was pumped through the apparatus, and the present type, with the closed air circuit, furnish very accurate means of studying a large variety of problems which have to do with the fundamental laws of nutrition and practical questions connected with the satisfactory feeding of man and domestic animals.

SPECIAL STUDIES OF THE YEAR.

During the year the experimental and editorial work connected with the dietary studies at the Government Hospital for the Insane has been completed and a bulletin describing the results in detail has just been published. The data secured are of great interest in themselves and will prove of material assistance in formulating dietary standards and in other ways, while the experience gained in conducting investigations will prove of great value in future work of a similar character. The studies showed that the diet at the Government hospital

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was well managed and that the food was abundant, of good quality, and well prepared. As the study progressed it became evident that in many ways economy in the preparation, handling, and storing of food might be introduced which would prevent waste and effect a considerable saving without making any radical change in the character of the menu. In other words, it was evident that, as in all business enterprises, more careful and expert management would prove valuable.

The studies concerned with the nutritive value and digestibility of flours of different grades have furnished very interesting data and the material now accumulated seems sufficient for answering the much-discussed question as to the comparative value of different sorts of flour ground from a given lot of wheat. It seems fair to say that the grades of flour known as whole wheat and graham contain a somewhat larger proportion of protein and ash than the patent grades, but are inferior as regards the thoroughness with which they are digested. Judging, therefore, by the total material which the body receives, the various sorts of flour are practically equal in value. The mechanical effect which the coarser flours exercise on the digestive tract should not be overlooked.

The dietary studies and digestion experiments with Maine lumbermen have given some interesting and valuable results. In fixing upon dietary standards it was desirable to have data regarding the kinds and amounts of food consumed by persons performing severe work and leading a very active outdoor life. Such conditions were met in the Maine woods. The diet with which the lumbermen were provided was comparatively simple in character though generous in amount. Generally speaking, the quantities eaten were fairly large, furnishing an abundance of both protein and energy. The food was quite thoroughly digested, no difference being observed between these men and those living and working under more usual conditions.

At the University of California, the investigations concerning the nutritive value, digestibility, and place in the diet of fruits and nuts have been continued and important data are being accumulated. The bulletins already published, which report the results of these investigations, have been widely circulated, showing that there is a popular demand for information along these lines. A popular bulletin has been published showing how a surplus fruit supply may be used in the household for the preparation of jams, jellies, and similar products, a class of foods which may be made to supply carbohydrate material in a palatable and attractive form, while at the same time the acids and other bodies which the fruits contain are believed to exercise a beneficial effect on the system.

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IRRIGATION AND DRAINAGE INVESTIGATIONS.

METHODS AND PROBLEMS.

During the past year the office of Irrigation and Drainage Investigations made a comprehensive study of the methods and cost of preparing land for irrigation. The results show the need of a better understanding of this subject by farmers. Much has been done by the Government and the States to aid engineers in the right planning of dams and canals, but farmers have not been aided in like measure in understanding how to get the best results out of the water when furnished. A bulletin published by the Department gives descriptions and illustrations of the tools used in grading land and building laterals and of the leading systems in use in distributing water in fields, orchards, and gardens. These studies show that the cost of preparing land for irrigation is far greater than has been realized, varying under flooding from $2 to $5 an acre and under the check system from $8 to $25 an acre. Here is a large opportunity for saving money to farmers by aiding them in choosing the method best suited to their conditions.

Last year a working agreement was entered into with the Western experiment stations for the systematic collection of information on important features of irrigation practice, which will enable this Department promptly and at small cost to collect and disseminate information of great practical value. This year the subjects studied were the methods of measuring water, the rate of rise of soil water during the irrigation period, and the use of cement and concrete instead of wood in irrigation structures.

DUTY OF WATER AND APPLICATION TO SOIL.

The increasing value of water has given added importance to the studies of its duty, which have been a leading feature of this investigation from the outset. Rights which originally were purchased for $5 an acre now sell for $35 an acre. Annual water rentals have risen in certain districts from $1 to $7 an acre. Every extravagant appropriation of water is a direct incentive to waste, and excess contracts and decrees will continue to be made so long as the quantity actually used has not been determined by accurate impartial measurements. This fact is giving the work of the Department increasing importance. Its reports are being used in fixing water-right decrees, and measurements of the duty of water on streams where adjudications are proposed, are urgently requested.

Scarcity of water in the arid West makes it desirable that it shall be used by irrigators in the most economical and skillful way. To aid in making this possible the Department is carrying on a series of scientific studies to determine the quantity of water which will give the

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best results and the best method of applying it to crops. In one important irrigated district these measurements show that the quantity needed to irrigate 60 acres of land under the method in common use will irrigate 100 acres when applied by another equally feasible method. They also show that the time of irrigation and the quantity of water used have an important influence on the quality as well as on the yield of crops.

PUMPING WATER FOR CROPS.

During the past season records of the performance of over 2,000 irrigating pumping plants, scattered from Texas to Washington, have been obtained. These included many types of pumps operated by gasoline, crude oil, distillate, by steam generated by means of oil, coal, and wood, by electric motors, windmills, and water power. The rapid extension of pumping as a means of extending irrigation gives great practical importance to these studies.

Wind is one of the neglected but promising sources of power for providing water for irrigation and for doing other farm work. An arrangement has been made with the department of farm mechanics in the Iowa State College to supplement the field studies made during the year by more careful tests of the efficiency of different makes of windmills. The makers of these machines have manifested much interest in these investigations and have not only offered to supply the mills needed for testing free of cost but to manufacture others according to any special design suggested by this Department.

Last season's pumping studies lead to the conclusion that there is a broad field for irrigation by pumping; that where the lift of water is less than 50 feet the number of failures are comparatively few. The failures noted have been due to two principal causes: Lack of mechanical knowledge or skill on the part of farmers needed to keep machinery in proper condition; and the selection of pumps of too great or too small capacity for the work to be done.

IRRIGATION IN THE HUMID SECTIONS OF THE UNITED STATES.

The studies of irrigation in Italy show that irrigation is highly profitable in a region having a larger rainfall than the Mississippi Valley, and there seems no doubt that in a similar way it is to have a large field of usefulness in the eastern and southern portions of the United States. One of the special crops which require irrigation is cranberries, and a cooperative arrangement has been made with the experiment station of Wisconsin and the Wisconsin Cranberry Growers' Association, under which the Department is attempting to formulate the principles which should govern the irrigation and drainage of cranberry beds. The studies made in Wisconsin are being supplemented by similar studies in New Jersey.

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In the rice districts of Louisiana and Texas practically all the water used in irrigation has to be pumped. The quantity used and the performance of different types of pumps in providing it are controlling factors in the success of this industry. Both these have been studied during the past year.

There is a large territory in central Arkansas which is believed to be well suited to rice growing. The Department is cooperating with the State experiment station to ascertain whether it will pay in this section to pump water to irrigate rice. The results this year, while encouraging, show that it will require considerable experimental work to place the industry on an assured basis.

DRAINAGE INVESTIGATIONS.

Crop production is being extended in this country in three ways—(1) by reclaiming, through irrigation and drainage, lands hitherto worthless or yielding only a nominal return; (2) by improving soil conditions in lands already under cultivation; (3) by scientific rotation and intensive cultivation of crops.

Since soil drainage is an important factor in all of these, the promotion of practical and efficient methods may do much for the general improvement of agriculture. Original investigation, combined with careful scrutiny of current practice in this and other countries, will enable this Department to place before State and district authorities, cultivators, and landowners the methods and practices suited to their conditions.

The following work was carried on during the year:

(1) An examination of some of the irrigated lands of Utah for which drainage is urgently needed, the giving of advice concerning plans, and the beginning of some experiments in tile drainage to determine the operation of underdrains in certain soils.

(2) The examination of several large drainage projects in the Middle West, in company with engineers, county boards, and interested landowners, followed by reports and recommendations of plans. About 400,000 acres of land are affected by these projects, with an estimated outlay for drainage of $1,000,000.

(3) Collecting and classifying field data upon the construction of levees for protection of river bottom lands; their ditching and drainage by pumps; construction, duty, and operation of land dredges; the construction and behavior of drainage ditches of various sizes.

(4) Collection of data regarding the operation of the older systems of tile drainage in the Middle West, with respect to determining how far conditions may be improved by reconstruction.

A preliminary examination of a portion of the Everglades in Dade County, Fla., was made in conjunction with the Bureau of Plant Industry, and it is thought that the Everglade soil can be made profitable for

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growing subtropical fruits if it can be sufficiently drained. In view of the interest taken in growing fruit and vegetables in southern Florida for the Northern winter markets, the reclamation of the Everglades merits further attention.

The lines of work carried on during the present year indicate the widening importance of this branch of agricultural improvement. The condition of much of the farming land in the older irrigated districts, and especially in Utah, demands prompt and active relief through drainage, or the loss already suffered by bogging of the land will be rapidly augmented. The Department can render great assistance to the people of these sections by enabling experts to direct and assist in starting practical drainage operations in localities where farmers are ready to begin.

An entirely different class of problems has been encountered in connection with the drainage of the peat swamp lands of central Wisconsin. Here the assistance of the experts of the Department has been requested in order to determine the manner in which drainage should be accomplished and regulated during the subsequent treatment of these marshes.

The reclamation of tidal marshes is a subject upon which numerous inquiries have been received and which may be profitably studied.

The further development of the prairie lands of Arkansas and the heavy cotton lands of Mississippi will depend upon the introduction of more thorough methods of drainage. There is no public information available bearing directly on the treatment of the drainage problems there encountered, although it is a fundamental matter in the development of certain lands in these States.

The drainage experts of the Department have given considerable time and thought in advising with and aiding agricultural colleges and stations about courses of instruction in drainage engineering and the carrying out of experiments in drainage. The establishment of these courses of study and the special training of men to carry out this branch of farm improvement promise much for the betterment of soil conditions and soil production in future years. The success of these classes is shown by the fact that Illinois has 42 and Iowa 65 students at present enrolled in drainage engineering.

AGRICULTURAL ENGINEERING AND CONDITIONS.

The valuable results which have come from including irrigation and drainage in the work of the Department leads me to believe that this investigation should include two other branches of agricultural engineering with which they have a close relation. These are farm buildings and farm machinery.

That this Department should give some attention to the convenience and healthfulness of farmhouses and farm buildings would not seem to

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require any argument. These have such vital relation to the attractiveness and profits of farming and to the improvement of the social and industrial conditions of farm life that they ought not to be ignored by this Department.

There is urgent need of study of the important question of ventilation and lighting in farm barns. A recent investigation carried on by the Agricultural College of Wisconsin has shown that scores of costly barns, intended to house valuable blooded live stock, and on which thousands of dollars have been expended to secure perfect sanitary conditions, are a complete failure so far as ventilation is concerned; and that this lack of proper ventilation is causing serious increase in the spread of tuberculosis and seriously impairs the profits of feeding. Hundreds of farmers are delaying the building of barns because, while they realize the nature of the difficulty and the necessity for its remedy, they do not know how to accomplish it. It is a striking but admitted fact that we are so ignorant of the proper principles of barn ventilation that many of the costliest structures built in recent years have been the most defective in this regard.

There is another reason for this Department giving some attention to the subject of farm buildings. We are entering a transition period in which the cheap wood construction of former years is giving way to permanent structures of stone, concrete, and iron. Farm houses, through better water supplies, plumbing, and sanitation, are being made as convenient as those of the city. The working out of these changes involves so many new problems that the Department is being called upon by experiment stations, improvement associations, and communities for advice and information which if furnished could not but result in a marked improvement in the conditions of farm life.

MACHINERY AND MOTIVE POWER.

Closely related to the healthfulness, convenience, and cheapness of farm buildings is the right selection, care, and use of farm machinery. The studies of pumping machinery have shown that the most important factor in its successful use is the mechanical skill of the farmer, and we are beginning to understand that the increased complexity and cost of farm machinery make the education of the American farmer along these lines more and more desirable.

No more significant change is taking place in American agriculture than the extent to which different kinds of motive power are taking the place of men and animals. The use of the traction engine and automobile in the place of the horse on the country roads, the employment of gasoline, steam, wind, and electric power to operate mowers, threshers, plows, feed cutters, corn huskers, and dairy machinery are illustrations of epoch-making changes that are now going on on every modern American farm. On one ranch in California there is $60,000

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worth of farm machinery operated by some other power than animals or man. For want of proper information these changes are involving farmers in serious mistakes and large losses. They buy motors not suited to their requirements or which they do not know how to operate. They buy machinery not adapted to their condition and cause its rapid destruction by not knowing how to care for it.

There is made and sold each year in this country about $100,000,000 worth of farm machinery. Fully one-half of this goes into the hands of men who do not know how to select it wisely or to keep it in proper condition. The waste which results runs into millions of dollars annually. In addition, implement manufacturers lose large sums in making and attempting to introduce machinery unsuited to the work it is intended to perform, with a resultant loss to both farmers and manufacturers.

Realizing the need of improvement in these matters, and partly to meet the requests of implement manufacturers for young men having agricultural and mechanical training which will enable them to design and construct implements suited to the conditions of the American farm, a number of agricultural colleges and experiment stations have inaugurated courses of instruction and begun systematic experimentation for the purpose of bringing about a general diffusion of intelligence about this feature of farm work. They have appealed to this Department for aid in this work similar to that already given them in other lines of agricultural investigation.

TESTS OF CORN PLANTERS AND WINDMILLS.

As illustrating the important results which are destined to come from the inauguration of this work, one of the results of an investigation carried out by the Iowa State College, a pioneer in this line of education and experimentation, will be given. It began its study of farm machinery with the operation of corn planters, because no single factor contributes more to the yield than securing a uniform stand, and this is impossible if the seed is not planted evenly. The machines for planting corn in hills are intended to drop from three to four grains, yet farmers have been buying, and implement makers manufacturing and selling, planters without any definite knowledge as to how they behave in this respect. In making this test all of the leading machines were included. It brought out the following significant facts:

(1) That no planter now made will drop evenly unless the grains have been graded. The introduction of seed-grain graders followed, and was an immediate, important, practical gain to agriculture and to manufacturers of this kind of machinery.

(2) That with graded grain certain types of machines do accurate work.

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(3) That other types will not drop evenly under any conditions.

The important and encouraging feature of this investigation has been the interest shown by manufacturers who have accepted the results as impartial and conclusive. Makers of machines found defective were as ready to accept the results as the makers of those which operated properly, the defects being at once corrected.

The test of windmills by the Iowa State College to determine the designs and sizes best suited to lifting water for irrigation promises to lead to important results in extending the use of this motive power in grinding grain, handling and storing produce, and doing some other kinds of farm work practically without expense, which formerly required a considerable expenditure for man or animal power.

NEED OF AN EXPERT IN FARM BUILDINGS AND MACHINERY.

The requests of the colleges and stations for aid in carrying out these investigations and in planning courses of instruction have been supplemented by numerous similar requests from farmers for advice and assistance about the selection and operation of different kinds of farm motors and other farm machinery. In the absence of any special arrangement for dealing with these problems, they have been referred to the Office of Experiment Stations and dealt with by the Irrigation and Drainage division of that Office; but there are at present no funds which can be utilized for systematic work along these lines. I am of the opinion that results of great value, alike to the farmers and the manufacturers of agricultural machinery, will come from the extension of the Department's work in agricultural engineering to include studies of this character, in cooperation with the agricultural colleges and experiment stations. I have, therefore, asked Congress for an appropriation which will enable us to employ an expert in farm buildings and farm machinery, in connection with the irrigation and drainage investigations.

DIVISION OF PUBLICATIONS.

The publication work of the Department is a faithful reflex of its activity and growth. The diffusion of the valuable information acquired by the Department is effected almost entirely through this medium. The time was, indeed, when in spite of the comparatively few publications issued, the cost of printing them amounted to far more than half the entire expenses of the Department. At present the entire cost of this work is not even one-sixth of the total expenditures of the Department, and yet the number of publications issued during the past fiscal year aggregated 972. Of these, 379 were new, comprising about 23,000 pages of matter. The number of copies of all publications issued during the year aggregated 12,421,386. The

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600 reprints attest forcibly the extent of the demand for the Department publications.

Of the whole number printed 415 were Farmers' Bulletins, of which 25 were new and 390 reprints. The total number of copies of these issued during the year was about 6½ million, very nearly 5 million being distributed upon the orders of Senators, Representatives, and Delegates in Congress.

A very gratifying feature reported by the Department Editor is the constantly increasing demand for the Department publications by educational institutions, mainly for class work. This has added, however, very much to the demands made upon us, and, unfortunately, has greatly increased the instances where it has been found impossible to comply with applicants' requests owing to the exhaustion of the supply.

This suggests the possibility, with the cooperation of Congress, of utilizing, after sufficient time has elapsed, a portion of the unused Congressional quotas of many of our documents. If some plan could be devised, with the approval of Congress, whereby such unused quotas could be made available to the Department, a great deal of valuable matter would go into circulation which at present is not used in any way.

It is gratifying to be able to report that Congress at its last session adopted a resolution authorizing the Superintendent of Documents to utilize the funds received by him from the sale of public documents to reprint such as are in continuous demand, subject to the approval of the head of the Department from which the document to be reprinted had emanated. This official courteously supplies the information that out of a total of 47,800 Government documents disposed of by him during the fiscal year, for which he received the sum of $12,606.17, 31,860 were publications of this Department, and the amount received therefor was $4,309.60. This again testifies in a marked manner to the increasing appreciation of the work of the Department, especially in view of the very large gratuitous distribution, not only directly through the Department, but also through members of Congress.

Every effort has been made to reduce the cost of printing. The editions have been restricted to actual and urgent requirements, and every means to reduce expenses, short of interfering with efficient service, has been resorted to. In the matter of illustrations especially, originally a very natural source of extravagance, rigid restrictions have been imposed. As a result, notwithstanding the considerable increase in the number of publications and in the total number of pages of new matter, the number of illustrations in the new publications issued during the year has been reduced by over 500, or more than 20 per cent of the previous year.

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THE LIBRARY.

The Department's collection of agricultural and technical scientific literature has been enriched the past year by the addition, by purchase and gifts, of more than 4,000 volumes. As a working library for the practical agriculturist and scientific investigator this collection of books now stands unsurpassed by any single collection. Some of the special collections of technical scientific works rank among the first in the country. More than ever before have the resources of the Library been made available to scientists in various parts of the country. Loans of this nature, which do not interfere with the progress of work in the Department, are greatly appreciated by experiment station workers in particular. Among the many valuable additions to the Library the past year have been a number of rare entomological works, which have long been needed to make the collection of books on this special subject more nearly complete. A printed catalogue of the books on entomology in the Library will be issued in a few months, thus adding another contribution to the printed subject-catalogue of the Library.

In return for the large number of Department publications transmitted to foreign countries through the Library, the number of exchanges from governments, institutions, and societies has greatly increased. These publications cover largely the results of current scientific work abroad and are of signal importance in the work of the Department.

The cataloguing of current accessions has practically been kept up to date. Printed index cards for the Department publications have been issued in larger numbers than before to meet the increasing demand from libraries in all parts of the country which receive the publications indexed. In addition to these cards similar cards have been prepared for three important agricultural periodicals, the printing, distribution, and sale of the latter cards having been carried on in cooperation with the Library of Congress. The quarterly Library bulletin of accessions has been regularly issued.

The number of volumes bound the past year has exceeded that of any previous year, yet the desired number of 3,000 volumes a year, until there are no unbound volumes on the shelves, has not been reached from lack of sufficient funds to provide for this work.

With the growth of the Department the work of the Library has increased proportionately, both in the direction of the purchase of books and periodicals and in respect to reference work in connection with current investigations. Each year its steadily increasing resources make the Library a working collection more and more depended upon for necessary data in the furtherance of Department work in its numerous branches.

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ACCOUNTS AND DISBURSEMENTS.

The total amount appropriated by Congress for the expenses of the Department for the fiscal year ended June 30, 1904, was $5,258,160, an increase of $244,200 over the appropriations for the preceding year. Of this amount about four and one-half millions had been expended at the close of the year, and the unsettled accounts were nearly sufficient to consume the unexpended balance of $768,839.43. The appropriations for the current year aggregate $5,942,040, an increase of $683,880 over those for the year ended June 30, 1904.

There was received from various sources and deposited in the Treasury the sum of $11,322.58. Among the larger items of these receipts were $4,392.46, resulting from sales of condemned property, $2,960.69 from sales of American products in Europe, and $2,337.33 for telegraph service by the Weather Bureau.

The amount appropriated for rental of buildings for the use of the Department in the District of Columbia for the current fiscal year is $39,820, an increase of $11,920 over the appropriation for the past year.

During the year buildings for the Weather Bureau have been completed at seven different points at a total cost for sites and construction of $70,900. Buildings are in course of construction at four points, the total cost of which will approximate $43,642. The total value of buildings and sites now owned by the Weather Bureau in the District of Columbia and at other points is $382,662.67. The erection of buildings for the use of the Weather Bureau saves a large annual expense for rentals.

PERSONNEL OF THE DEPARTMENT FORCE.

The annual report of the Appointment Clerk shows that the total number of persons constituting the body of the Department of Agriculture on July 1, 1904, was 4,504, an increase of 2,160 since July 1, 1897. In addition, there are nearly a quarter of a million special correspondents and reporters who, although receiving no financial remuneration from the Department, cooperate with it and render it much valuable service. These deserve the utmost credit for the public spirit which animates them.

PROGRESS ON NEW DEPARTMENT BUILDINGS.

The work connected with the new buildings for the Department of Agriculture, authority for which was announced in my last report, has progressed satisfactorily during the year. As already announced, Congress has authorized an expenditure of $1,500,000 for these buildings. For the greater part of the past year the architects have been

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